BAT **Bischoff Analysentechnik GmbH**

OPTICHROM® Computer Communication Protocol Manual

Includes Host Computer Interface –
Simple (HCI-S)
ASCII (HCI-A)
HCI-H
HIWAY

Revised Printing – April 2007 2000534-001 **Copyright Notice**

Inquiries regarding this manual should be addressed to Bischoff Analysentechnik GmbH, Taunusstr. 27, 61267 Neu Anspach, Germany

Safety Practices and Precautions

Safety First

This product has been designed and tested in accordance with IEC Publication 10101, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains information and warnings which have to be followed by the user to ensure safe operation and to retain the product in a safe condition.

Terms in This Manual

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

Terms as Marked on Equipment

DANGER indicates a personal injury hazard immediately accessible as one reads the markings. CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

Symbols in This Manual

This symbol indicates where applicable cautionary or other information is to be found.

Symbols Marked on Equipment

DANGER - High voltage

Protective ground (earth) terminal

ATTENTION - Refer to Manual **Grounding** A grounding conductor should be connected to the grounding terminal before any other **the Product** connections are made.

Correct Before switching on the power, check that the operating voltage listed on the equip- **Operating** ment agrees with the available line voltage.

Voltage

Danger Any interruption of the grounding conductor inside or outside the equipment or loose **Arising From** connection of the grounding conductor can result in a dangerous unit. Intentional inter- **Loss of** ruption of the grounding conductor is not permitted.

Ground

Safe If it is determined that the equipment cannot be operated safely, it should be taken out **Equipment** of operation and secured against unintentional usage.

Use the To avoid fire hazard, use only a fuse of the correct type, voltage rating and current **Proper Fuse** rating as specified in the parts list for your product. Use of repaired fuses or short circuiting of the fuse switch is not permitted.

Safety Guidelines

DO NOT open the equipment to perform any adjustments, measurements, maintenance, parts replacement or repairs until all power supplies have been disconnected.

Only a properly trained technician should work on any equipment with power still applied.

When opening covers or removing parts, exercise extreme care "live parts or connections can be exposed".

Capacitors in the equipment can still be charged even after the unit has been disconnected from all power supplies.

Table of Contents

Introduction to Computer Link Specifications in the OPTICHROM ADVANCE® System

The OPTICHROM ADVANCE® System provides serial interfacing to other programmable devices such as control systems or host computers.

There are currently three available software protocols. They are as follows:

HOST COMPUTER INTERFACE – SIMPLE (HCI-S)

This interface is essentially a printer type of interface where information is transmitted without any handshake. Though

no data checks are provided other than the normal character serial data checks, this interface is most applicable where someone has to write a interface to the Advance system and is limited to some high level language such as basic.

HOST COMPUTER INTERFACE – ASCII (HCI-A)

This interface is a standard type of computer interface with transmission of the results in binary and the usual types of checks as checksum and retransmission on failure of acknowledge by either system. When a user is interfacing in some language such as assembler or has previously had an OPTICHROM system computer interface, this may be the best choice for interconnect.

HOST COMPUTER INTERFACE – HIWAY (HCI-H)

This interface is the easiest to interface if the system already has a MODBUS interface to the MODICON 584 Binary version (which is a standard control system interface). As a standard interface is used, only application programming is necessary in both the control and chromatograph system, providing the greatest assurance for a quick, trouble-free startup of the computer link. The greatest amount of data integrity is performed via this interface, with the host system being able to determine an operational status for each analyzer. Data from this interface can be directly displayed on the control system operator consoles just as data from any other point in the control system.

The user must select which of these interfaces is best suited for his application. This manual describes in complete detail the complete operation of each interface, so the user may check each description to see if the needed functions are included in each interface. This description may also be used to accomplish programming for any of the interfaces.

Section 1. Host Computer Interface - Simple (HCI-S)

Contents

This document describes hardware and software requirements for connecting a computer to the Advance Analyzer System. The software described here is referenced as the "Simple" protocol.

Definitions

This document is written from the viewpoint of the Advance System and equipment.

The term "analyzer" refers to Siemens Applied Automation, Inc. Advance analyzer hardware including gas chromatographs.

The term "HCI-S" refers to a specific electronics printed circuit board installed inside appropriate Advance equipment.

The term "HOST" refers to a computer or other device external to the Advance analyzer system to which communication from analyzers is to be directed. It is presumed that the HOST is another computer or programmable device.

The term "Event" refers to a software program existing in Advance equipment. An Event may be thought of as some action which the Advance analyzer is programmed to perform. Such programming is generally accessible to the user and may be modified in the field by appropriately trained personnel. Such programming is not accessible for modification by the HOST directly. Examples of events are "transmit results to the HOST computer", "perform self-calibration", "switch to and analyze some specific stream", "remove some specific stream from the analysis sequence", "enable" or "disable" a predetermined error checking capability, and others.

The term "Result" refers to a data item which is a numerical value of something measured by the analyzer. The purpose of a result transmission is to send all of the analysis results from an analyzer to the HOST.

Functions

The Advance analyzer HOST communications link allows for the following functions to be performed.

1 The HOST may activate an event. When the event which is activated causes the analyzer to transmit analysis results to the HOST computer, this function is in effect, a "HOST request for results."
2 The analyzer may initiate its own transmission of results to the HOST. Such a transmission may occur for a variety of reasons as selected by the user. The most common reason is the completion of an analysis cycle and the calculation of new results needing to be transmitted.

Hardware

Communication is via an RS-232-C compatible serial data link. A subset of the signals described in the RS232 specification is used and voltage levels on all signal lines are compatible with that specification.

Three signal lines only are used. These are:

XMT Data Transmit
RCV Data Receive
GND Chassis Ground

All wiring connection to the Advance system are via screw terminals on field termination barrier strips. Location and numbering of the screw terminals used will vary depending on total system size and configuration. Exact information for any particular installation is provided with custom System Installation Documentation provided to the user at the time of system sale.

Data rates are field adjustable by strapping on the HCI-S. In the absence of specific information, the default baud rate is 9600.

7 Data Bits
1 Parity Bit (odd)
1 Stop Bit

Protocol - General Information

The HCI-S interface board is the same hardware device used to support printers in the Advance System. When the device is used to implement the "Simple" communications protocol as described in this specification, specific applications software is provided. This applications software is what formats the logs as described below. In general, the log formats described in the following sections are capable of some modification in the field by the user if he desires. However, the formats described are what is provided by Siemens Applied Automation, Inc. at the time of system

shipment. It will be noted that certain portions of the format described below are prompt messages. These messages are intended to assist human operators in this protocol except that the HOST must expect the messages and accommodate their presence. Generally, the messages are useful as well in field troubleshooting and debug of a communications link.

Often a HOST computer using this protocol may be fully simulated by use of a printer, CRT, or other keyboard device. It may be noted further that these prompt messages may not be inhibited and timing associated with them (i.e. response and turnaround time) is not controllable.
Note, if these messages create a problem, a pair of HCI-S boards may be used together. In this type of configuration, one board is used to request results and the second board is used to receive them. That is, the HOST transmit lines are connected to one board and the HOST receive lines are connected to another. The "prompt" messages occur only on the board on which the request is being made and only the result transmission per se appears on the board used to receive data.

Also note that this protocol is often compatible with existing device driver type software that may already exist. For example, software that supports interactive communication with a human operator at a keyboard device such as a CRT may often be used directly to interface to the Advance system. One variation that is generally required is that "answer back" or "echo" functions that cause a typed character to be echoed back to a CRT screen must not be used. The Advance HCI-S is not expecting its transmitted characters to be echoed. In converse, however, the HCI-S does echo characters which are sent to it. As noted above, if this creates difficulties for the HOST, a second HCI-S might be used.

As noted above, two functions are supported by this communications protocol. These two functions may be interchanged as desired by the user in any particular application. Or only one of the functions may be used. No special configuration of the Advance hardware or software is required to support this option; usage preference may be determined by the user at any time. If the user chooses to use both HOST polling of analyzers for data and analyzer initiation of data transfers, this is acceptable. All messages from the analyzer are self-identifying; that is they contain their own analyzer and stream number identifications. The system does provide that if the HOST has requested a result log, the log requested is transmitted next, immediately following completion of any log in progress at the time of the request.

Result Log Format

Following is a description of the format of any analyzer results transmission to the HOST.

Any result log is transmitted as a string of ASCII characters which are time and date corresponding to sample injection, unit identification and alarm and operational status, and analysis results data, with each data item separated by an ASCII "comma" as described here. The message is terminated with an ASCII "return" character.

HHMM , Time in 24 hour format; hours and minutes

DD	, Day
MM	, Month
YY	, Year
SS	, Stream Number of results
AAA	, Analyzer Number making transmission
TTT	, Analyzer current Status
CCC	, Alarm code of most significant error

RRRRRRRRRR, Result 1 RRRRRRRRRR, Result 2
etc. as required by particular application. RRRRRRRRRR Result last - (not followed by comma) <C/R> ASCII Return character All data items stated above are transmitted as numbers. The time, date, analyzer status and identification items are transmitted as whole integer numbers with the number of character spaces indicated. The result items are transmitted as real numbers in a floating point configuration. The field width for the result

numbers is 10 characters inclusive of the decimal point. In all case, leading zeros are replaced with spaces. The item format for a real number is in the following format:

44.86
2.48736
-14.42
0.00567

Request Format

Following is the format of a HOST request message. Portions which are underlined are response or "prompt" messages transmitted from the HCI-S to the HOST.

CTRL/a Obtain access to HIWAY (HEX '01')

EVT, PRNT, or HELP? HCI-S interjected prompt.

EVT<xx,yyy,zz,<C/R> Request a log as defined next.

REQUEST COMPLETE <C/R>

Note: xx is Event ID. This may vary with application but is generally 32.

yyy is the desired analyzer number from 1 to 254. Appropriate numbers are specified in custom system documentation.

zz is the desired stream number from 1 to 32.

The message "REQUEST COMPLETE" is the normal termination of a valid request and immediately precedes the subsequent result log itself. If an error is made, certain alternate messages will appear here. These are:

– "xxx NOT DEFINED" OR "ANLZ NOT DEFINED" meaning the desired analyzer number does not exist in this system.
– "Awaiting Response" or "DEVICE DOES NOT RESPOND" meaning the desired analyzer exists but it is not responding for some reason, generally due to power outage at the analyzer.

Additional Information

As noted in this manual, specific information about particular applications is necessary to fully define the communications link. That information is provided in custom application documentation which comes to the user at the time of sale. It is solely application dependent and therefore cannot be made available in general form. This document references that documentation where appropriate.

In applications performed solely by the user, information referred to as custom may be generated by the user himself. The Advance system is capable of being fully applied in the field. The user should reference standard system manuals.

Error Conditions

Several types of error conditions may be defined as desired by the user. As noted above in this document, only one error message is generated during a message transaction per se. Stated here are other errors that may occur or be generated optionally in the field.

1 Hardware error resulting in parity errors in transmission to or from the HOST. If such an error is detected in a message from the HOST, the Advance system ignores the entire transaction. If such an error is detected by the HOST, it may take any action the user deems appropriate.
2 Data errors detected by the analyzer. Such errors include concentration range limit checks performed by the analyzer or normal operational or maintenance warnings generated by the analyzer. Such errors are included in the Results transmission and are transmitted as numerical or alphanumeric data in lieu of a result in the list described above. Such error indications may be inserted at any point in the list. (Note, this document does not describe the types of error checking and data monitoring that are possible with the Advance system. For further information in this area the user is directed to Advance system documentation.)

Section 2. Host Computer Interface - ASCII (HCI-A)

Contents

1.0 GENERAL

This manual describes the communications hardware and software protocol requirements that exist for a user of OPTICHROM ADVANCE® equipment when he desires to connect an external computer or programmable data gathering device to the Advance equipment. Various software protocol options are available from Siemens Applied Automation, Inc. These variations are intended to provide the user with a possibility of choosing software which is most closely compatible with his requirements.

This specification deals solely with that software protocol option referred to as "HCI-A, ASCII" protocol available on part number 2000130-002. Other available options are discussed in other documentation. It may be noted that the ASCII protocol option presented here has several optional configurations available in itself. Optional configurations presented in this manual are fully field selectable. No configuration which cannot be selected by the user in the field is discussed in this manual.

This section, 1.0, presents an application of the HOST Computer Communication Interface - ASCII (HCIA) within the OPTICHROM ADVANCE® system.
Section 2.0 pertains only to the message structure and protocol requirements of the communication link between a HOST computer and a HCI-A board.

1.1 Terms and Reference Information

1.1.1 The terms "chromatograph", "analyzer", "analyzer system", and "Advance" will be used synonymously to indicate a unit or a system of gas chromatographic analyzers supplied by Siemens Applied Automation, Inc..

1.1.2 The term "Data Hiway" refers to the Advance Data Hiway which is a communication scheme that is proprietary to Siemens Applied Automation, Inc. and permits multiple Advance devices to be interconnected for purposes of communicating with each other. Physically, the Data Hiway is realized only as a four conductor cable which passes from unit to unit.

The user never connects any device to the Data Hiway other than devices supplied by Siemens Applied Automation, Inc. Communication from advance chromatographs on the Data Hiway and other computers as described in this paper is performed through an intermediate device supplied by Siemens Applied Automation, Inc.. This device is a printed circuit board called the "HCI-A". The HCI-A connects to the Data Hiway on one side and to the user's computer system on the other side. This is further described below in subsection
1.2.

1.1.3 The terms "HOST" and "computer" will be used synonymously to reference a computer or other device external to Siemens Applied Automation, Inc. OPTICHROM ADVANCE hardware. It is presumed that it is desired to transmit measurement information from Advance to the HOST. Details of HOST structure are not covered here.

1.1.4 The terms "Result", "Buffer", and "Factor" refer to tabulated items of data or other information that exists in the Advance analyzer system. In general the term "Result" is reserved for one item of measured data which is ready for transmission to the HOST. All such data items are uniquely identified in each analyzer by a number 1 through 255.

"Result" data items can represent any desired item of information such as a measured value, a concentration range upper limit, a time or a date. In addition, so far as Advance sees it, items of information used by the HOST for validation of data are also "Results." Such items include analyzer status and stream status information.

1.1.5 The term "Event" refers to any short software program which exists in Advance analyzers. Additionally, each analyzer has one or more such Events included in its programming. Several such programs may exist in any one analyzer. Each Event is uniquely identified in a given analyzer by a number 1 through 255. The exact function that is performed by any Event is not defined in this specification, each Event is completely accessible to the user through user interface devices and may be modified by him at any time.

However, for this specification to apply, each analyzer must include one Event that causes the analyzer to transmit result information to the HOST. As is described in later sections below, the HOST "requests" result transmission (when desired) by activation of the Event program that causes this transmission to occur.

1.1.6 This manual is supplemental to other Siemens Applied Automation, Inc. publications including standard manuals published by Siemens Applied Automation, Inc. in support of the OPTICHROM ADVANCE System. These manuals include as a primary reference the Application Modification manual which describes the application programming language available to users.

1.2 System Configuration

In service, an Advance system will consist of one or more gas chromatographs interconnected by an Advance Data Hiway. In addition to the various chromatographs, there may also exist one or more user service panels and one or more input/output chassis containing various analog and digital I/O device and printer interfaces. Each chromatograph, each service panel, and each I/O Unit is a physical device and all are interconnected by the Advance Data Hiway. This configuration is then a network of devices. There is no "master" device or central device in the network. Each unit may at various times communicate with any other unit. Generally, the HOST is intended to obtain analysis results from all or some of the chromatographs. It may be apparent to the reader that this network configuration implies that the HOST must deliberately communicate with desired chromatograph units by knowing and using an identifier for each unit as required. This is discussed in Section 2.

Located in one of the I/O units or in one of the chromatographs is the HCI-A. The HCI-A is a single printed circuit board. It may be physically located at any point in the Advance network at any physical location which is desirable for the user. Exact location and methods of installation is the subject of other documentation.

Generally however, the HCI-A will act as a interpreter between the HOST and the OPTICHROM analyzer(s). This is accomplished by reformatting the HOST message format into the OPTICHROM ADVANCE Data Hiway (DH) format,

and conversely, reformatting the DH message format into the HOST message format.

There may be multiple HOST computers connected to the Advance system. Each HOST may access whatever data is useful to it and may be isolated from other data. Each HOST must be connected to a unique HCI-A board, which in turn is connected to the Data Hiway. Additionally, a single HOST may be connected to multiplier HCI-A's provided the HOST has the necessary hardware facilities. This is normally not done, but may be done particularly for backup.

1.3 Communication Capabilities

1) The HOST/Analyzer communications allow for the following functions to be performed:

2) The Host may select the Operating Mode of the HCI-A;

3) The HOST may Activate an Event at a selected analyzer (which includes requesting transmission of results);

4) The HOST may set all analyzers' clocks;

5) The ANLZ may transmit Results on an 'as available' basis.

6) The HOST may inquire if the HCI-A is on-line.

The operating mode of the HCI-A has some default setup parameters, which may be changed with the RIPPARM message sequence (see section 2.3.4.4). Four items may be set via this sequence: MODE, STRT, END and SECS. The MODE parameter permits selection of two types of result transmissions, of which new (0.0) is the default. The choices are new (0.0) which provides a two message interchange for results, or old (1.0) which provides a multiple message interchange of segmented result transmissions (to be compatible with some previous interface operation). The STRT parameter specifies the first character of the messages of which the default is STX (2.0). Choices are SOH (1.0) and STX (2.0). The END parameter specifies the final character of each message of which the default is none (0.0). Choices are none (0.0), EOT (4.0) and CR (13.0). The SECS parameters specifies the timeout for the HCI-A to await a response from the HOST of which 2.0 seconds is the default. The choices are 1.0, 2.0, 3.0, 4.0 and 5.0.

The HOST may cause activation of any defined event in any analyzer in the Advance system (see section 2.3.3.4). The most common use of this capability is to request transmission of results in systems where results are not transmitted automatically on an as available basis. Actual definition of specific events is an application related item, though event 32 is the standard event definition of transmission of results.

The HOST may synchronize all clocks (which are maintained on an individual analyzer basis) by the TAD message (see section 2.3.3.5). The month, day of month, year, day of week, hour, minute and second are parameters.

The Advance system is usually setup to transmit result analyses as soon as the analyses are complete (see section 2.3.3.3). Each result transmission contains time and date, analyzer status, and component concentration.

The HOST may check at any time to see if the HCI-A is powered up and operating with the INQUIRE message (see section 2.3.3.9).

NOTES

> As was alluded to in the definitions subsection 1.1.5 above, the HOST is allowed to "request" Result information from any analyzer by activation of an appropriate Event. Thus message transaction "2" here may constitute a "HOST Request for Results". Additionally, any analyzer may cause an Event to be activated at any time on its own initiative. This is the basis of message transaction "4" mentioned here.

2.0 COMMUNICATIONS INTRODUCTION

Information in this section pertains only to the communication link between a HOST computer and an HCI-A (item number 2000130-002).

2.1 Communication Format

Communication between a HOST and the HCI-A board is serial, asynchronous by character, synchronous by bit, at a minimum rate of 110 baud and a maximum rate of 9600 baud. (4800 baud maximum for current loop connections)
The serial format is chosen by the user by setting of switches U43 and U27 on the board.

SELECTION			U43		U27	
OPTIONS	S1	S2	S3	S4	S4	SWITCH = ON
HCI-H	X		X	X	X	
PCI					X	
7, ODD, 2 STOP					X	
7, ODD, 1 STOP	X				X	
7, EVEN, 2 STOP		X			X	
7, EVEN, 1 STOP	X	X			X	
8, NONE, 1 STOP						
8, NONE, 2 STOP		X				
8, EVEN, 1 STOP	X	X				

2.2 Message Types

Communication on the serial communication link is formatted into messages. There are nine message types:

Message Identifier
Number Dec'l Hex Originator Description

1 128 80 Both OK - Message Acknowledgment 2 129 81 HCI-A NO - Request Not Accepted 3 130 82 HCI-A TOR - Transmission of Results 4 131 83 HOST HAE - Activation of an Event and Request for Results 5 132 84 HOST TAD - Time and Date Set 6 133 85 HOST PARM - Selection of HCI-A Interface Parameters 7 134 86 HCI-A RIP -Request for Interface Parameters 8 135 87 HOST HRST - Request for HCI-A status bits 9 136 88 HCI-A STTS - Send 'status' bits

All of these messages are used in the poll/response form, i.e., two parts:

1) a poll from device 1 to device 2,
2) followed by a response from device 2 to device 1.

Four of the message types (HAE, TAD, PARM, and HRST) are initiated by the HOST. Two messages
types (TOR and RIP) are initiated by the HCI-A.
Three message types (OK NO, and STTS) are response messages to a poll.

In any given application, two or more of these message types may be used as required.

Subsection 2.3.1 describes the general protocol for ASCII data,
Subsection 2.3.2 describes the HOST protocol,
Subsection 2.3.3 describes the structure of each type of message,
Subsection 2.3.4 gives examples of each message type.

2.3 Protocol

2.3.1 General Protocol

All messages are transmitted in ASCII mode with some reserved protocol characters as

follows:

NAME MNEMONIC HEX CODE

Start of Header SOH X'01'

Start of Text STX X'02' End of Text ETX X'03' End of Transmission EOT X'04' Inquire ENQ X'05' Acknowledge ACK X'06' RETURN C/R X'0D'

A poll or response consists of:

1) The start char (SOH, STX,)

2) The DATA+ bytes

3) The ETX char

4) The checksum bytes (2)

*5) The end byte (EOT, CR)

* Item 5 may not exist. This item is selectable by the HOST as described in the "PARM" message below in another section.

The SOH (STX) and ETX are one byte each. The checksum is two bytes ASCII.

The DATA+ position consists of a variable number of items (Logical analyzer #, message type, stream number, results, etc.). Each item will be represented by a variable length REAL number, separated by a comma (X'2C' in ASCII).

If an item magnitude cannot be represented by eight (or less) digits, the value will be converted to exponential format.

Example:

A value of 123456789.0 would appear as '+.123456789E+09,'
A value of PI would appear as '3.1415927,'
A value of -0.0731538 would appear as '-.0731538,'
A value of -120.0 would appear as '-120.0,'
A value of 472.106 would appear as '472.106,'

The checksum (CKSM) is an 8-bit ADDITIVE SUM of all bytes, start character (SOH/STX) to ETX inclusive, converted to 2 ASCII chars. For example, a checksum of X'0D' would be transmitted as:

X'30' (which is the representation of the ASCII character '0'), and
X'44' (which is the representation of the ASCII character 'D').

Note: Only least significant 8 bits are transmitted, all other bits are not used.

Whenever a poll or response portion of a message received by the HOST or HCI-A is in error, it should be ignored. The poll or response received is in error if any of the following occur:

a. One or more bytes contain parity, framing, or device overrun errors.
b. Checksum generated does not equal checksum received.
c. Message format is violated.

2.3.2 HOST Protocol

The HOST may transmit either because the HOST wishes to initiate a message transaction with the HCI-A or because the HCI-A has initiated a transaction and the HOST needs to respond. In either case, the items described in this section apply.

To transmit, the HOST should follow these steps:

1 Wait until the current transmission being received is completed normally; or, if normal completion cannot be determined, wait for a period of two seconds with no characters received.
2 Send the appropriate poll or response transmission.

Whenever a valid poll is received by the HOST, the HOST must respond to the HCI-A within the time-out allotted (2 seconds is standard, selectable by the HOST). If the HOST does not send a valid response in the time allowed, the HCI-A will retransmit the poll until a valid response is received, or three tries have been completed (which ever occurs first).

In the situation where the HCI-A attempts to initiate a transmission to the HOST, the HCI-A will make three tries. If after the third attempt the poll does not generate a valid response, a warning alarm (decimal code number 27) may be generated for the active stream on the analyzer that initiated the poll. (This alarm normally is displayed on a user interface. Please reference other documentation for further description of Advance alarm processing.)

NOTES

The Advance system is capable of queuing (holding for later transmission) up to one result transmission for each process stream on each analyzer. This facility is used whenever there is extensive transmission activity. However, the HCI-A does not check to see if the HOST is present before initiating its transmission; that is the HCI-A does not use "RTS" and "CTS" interchange (the HOST RTS is not connected to the HCI-A). Therefore, it is assumed that the HOST is "always ready" to receive any transmission initiated by the HCI-A. If, in fact, the HOST is not ready and fails to respond to a transmission from the HCI-A, then an error condition is assumed and the HCI-A either retries its transmission up to a total of three attempts or initiates a user alarm in the Advance analyzer.
It may occur that both the HCI-A and the HOST simultaneously desire to initiate a transmission. In this case the line contention is resolved by the HCI-A not raising the CTS line while sending its poll to the HOST. This requires the HOST to queue its request until the current incoming message is completed.

Though the HOST cannot stop transmissions, it may delay them by dropping the DTR line as long as this is not dropped for longer than the timeout for a transmission. The default timeout is 2 seconds, though this may be varied from 1 to 5 seconds via the PARM message (2.3.3.6).

If the HOST does not receive a valid response to a poll, the transmit procedure must be restarted. In certain situations, the need to queue retries may occur. The HOST is responsible for the number of tries of any poll. Three tries is recommended.

Each poll and response message contain an Analyzer # and the type of message being transmitted or received (see message types listed in subsection 2.3.3 and described in subsection 2.3.4).

The Analyzer # is always the Logical ID # of the particular analyzer, except for a broadcast (TAD) to all devices, where the Analyzer # is defined as 255.

The timing and frequency of message initiations depend entirely upon the application.

2.3.3 Message Types

The nine message types (OK, NO, TOR, HAE, TAD, PARM, RIP, HRST, and STTS) listed in subsection
2.2 are described in detail in the following subsections.

A special message sequence (ENQ/ACK) is described last.

2.3.3.1 Message Acknowledgment (OK) Message

The "OK" message is a Response message and originates at either the HOST or HCI-A. Either the "OK" or "NO" message will be used in response to a HOST poll. Format of the OK message is shown in Table 2-1.

Table 2-1. Message Acknowledgment (OK) Message Format

HOST/HCI-A RESPONSE

STX ANLZ #
OK ETX
CKSM1
* CKSM2
(END)

NOTES

1 The start char may be either STX or SOH.
2 ANLZ # identifies the Logical analyzer of interest. Valid analyzer numbers are 1 to 254.
3 OK indicates the message was received and understood, and have a value of 128.
4 The CKSM is 2 ASCII chars. *5 The END char is selectable by the HOST.

2.3.3.2 Request Not Accepted (NO) Message

The "NO" message is a Response message and originates at the HCI-A. It is used to inform the HOST of a 'Request not accepted' status from the selected Analyzer. It is also used to inform the HOST of the "No more TOR data" condition in the ANLZ (status code 8). Either the OK or NO message will be used in response to a HOST poll.

Format of the NO message is shown in Table 2-2.

Table 2-2. Request Not Accepted (NO) Message Format

HCI-A RESPONSE

STX ANLZ #
NO
+ STATUS
ETX1 CKSM1
* CKSM2
(END)

NOTES

1 The start char may be either STX or SOH.
2 ANLZ # identifies the Logical analyzer of interest. Valid analyzer numbers are 1 to 254.
3. NO has a value of 129 and indicates:
a. The Request was not accepted by the Analyzer, or
b. No more TOR data to be sent from the Analyzer.
3 STATUS is the error code for the 'NO' response. 0 = Invalid data field in message 1 = No response from the analyzer 2 = Analyzer doesn't understand the request 4 = Event/Stream is not defined in the analyzer 8 = No more TOR data to be sent from the analyzer
4 The CKSM is 2 ASCII chars, CKSM1 and CKSM2. *6. The END char is selectable by the HOST.

2.3.3.3 HCI-A Transmission of Results (TOR) Message

The "TOR" message is a HCI-A poll message, and is used to transmit results from an

analyzer to the HOST on a basis of:

a) a preselected set of times,
b) as available, or
c) when manually activated.

Format of the poll/response form is shown in Table 2-3.

In the TOR poll, the results from a particular analyzer/stream are transmitted to the HOST.

If the poll is received by the HOST and is valid (see subsection 2.3.3), then the HOST should give the response indicated in Table 2-3. However, if the TOR Poll is not valid, no HOST response will occur and retries will be attempted by the HCI-A.

When no response is given for three tries of the poll, the HCI-A will generate a warning message to the analyzer, analyzer will generate a 27 alarm to alert operator.

A response must be received by the HCI-A within the time-out period.

Table 2-3. HCI-A Transmission of Results Message Format

HCI-A POLL HOST RESPONSE

STX STX ANLZ # ANLZ # TOR OK
\+ RSLT1 ETX
\+ RSLT2 CKSM1
: CKSM2
: * (END)

\+ RSLTn
ETX
CKSM1
CKSM2

* (END)

NOTES

1 The start char may be either STX or SOH.
2 ANLZ # identifies the Logic analyzer of interest. Valid analyzer numbers are 1 to 254.
3 TOR is a transmission of results from the analyzer, and have a value of 130.
4 OK indicates the message was received and understood, and has a value of 128.
5 See Table 4 for a standard definition of reults.
6 The CKSM is 2 ASCII chars, CKSM1 and CKSM2. *7. The END char is selectable by the HOST.

The Analyzer # identifies the Logical analyzer of interest, not the physical address of that analyzer.

Each analyzer will specify the number of results per stream that will be supplied to the HOST. Each result is represented by a variable length REAL number (limited to 14 characters, else it will be in exponential format), followed by an ASCII comma. See subsection 2.3.1.

See Table 2-4 for the standard result descriptions; note these are subject to change in special applications.

The analyzer maintains the last valid analysis for each stream. If an alarm occurs, it may inhibit the update of these results so the HOST can determine if the results are recent from the information supplied (see results 1 to 4 in Table 2-4).

Table 2-4. Standard Definition of Results

RESULT DESCRIPTION RANGE OF VALUES

1 Time of day 0.- 2359. 2 Day of month 1. - 31. 3 Month 1. - 12. 4 Year 0. - 99 5 Stream 1. - 32. 6 Analyzer # 1. - 254. 7 (Note 1) Analyzer status 0. - 2. 8 (Note 2) Alarm code 0. - 254. 9 Component #1 0. - 100. 10 (Note 3) Component #2 0. - 100. 11 Component #3 0. - 100. : :: : :: m-1 Component #n-1 0. - 100. m Component #n 0. - 100 (Note 4)

NOTES

1. Analyzer status may be specified by the user. In the absence of other specifications:
0=Analyzer halted.
1=Analyzer running normally.
2=Analyzer in single cycle mode, as for maintenance.

2. Analyzer alarm codes reflect operational errors, as:
i.e. The data in the message is good but some maintenance or other warning condition exists.
i.e. The data in the message is "old" that is, the data is from the last good analysis.

3. This table shows a typical definition of results. An actual definition (particularly as it pertains to the number and range of components) is variable per application.
As transmitted normally, 100.0 equals 100% of specified range, 54.28 equals 54.28%, etc. (No further scaling need be done).

2 Additional data, such as scaling information or results of calculations, may follow as required by individual applications.

0 = No alarms.
1 to 127 = Warning alarms

128 to 254 = Fault Alarms

255 = Not used.

2.3.3.4 HOST Activation of an Event (HAE) Message

The "HAE" message is initiated by the HOST. It is used to activate some preprogrammed operation (event) in the selected analyzer. Events to be activated are completely defined by

the application. Examples of events might be automatic calibration, stream skipping, relay activation or deactivation and Requesting Results (Event 32). The most common use of this function would be to request a transmission of results from the analyzer. This is accomplished with the HAE message with the following parameter settings: ANLZ # set to the analyzer number from which results are desired; HAE # set to 131; EVENT # set to 32; and STREAM # set to the stream number from which results are desired.

Format of the poll and response are shown in Table 2-5.

Table 2-5. HOST Activation of an Event Message Format

HOST POLL	HCI-A RESPONSE
STX STX ANLZ # ANLZ # HAE #	OK/NO
+ EVENT # ETX	
+ STREAM # CKSM1	
ETX CKSM2	
CKSM1 * (END)	
CKSM2	
* (END)	

NOTES

1 The start character may be either STX or SOH.
2 ANLZ # identifies the Logical analyzer being polled. Valid analyzer numbers are 1 to 254.
3 "HAE" activates an event at the selected analyzer, and has a value of 131.

#4. "OK" indicates the message was received and understood, and has a value of 128.

#5. "NO" indicates the request was not accepted by the Analyzer, and has a value of 129. The STATUS code indicates the reason for rejection.

1 EVENT # is the code number of the event being activated. Valid event numbers are 1 to 255, as restricted by the particular analyzer.
2 STREAM # is the stream of interest (used by Event #32, "HRFR"); or zero.
3 The CKSM is 2 ASCII characters.

*9. The END character is selected by the HOST.

2.3.3.5 HOST Time and Date Set (TAD) Message

The "TAD" message is initiated by the HOST. It is used to set the clock in all of the ADVANCE analyzers. Format for the poll/response sequence is given in Table 2-6.

When the message is received by the HCI-A, each analyzer's clock is updated. This message type is useful when the clocks of the HOST and ADVANCE analyzers must be synchronized presumably for purposes of data validity checks.

Table 2-6. HOST Time and Date Set Message Format

HOST POLL HCI-A RESPONSE

STX STX ANLZ # ANLZ # TAD OK MONTH ETX DAY OF MONTH CKSM1 YEAR CKSM2 DAY OF WEEK * (END) HOUR MINUTE SECOND ETX CKSM1 CKSM2

* (END)

NOTES

1 The start character may be either STX or SOH.
2 ANLZ # is defined as 255.
3 TAD sets the Time and Date, and has a value of 132.
4 OK indicates the message was received and understood, and has a value of 128.
5 The CKSM is 2 ASCII characters.

*6. The END character is selectable by the HOST.

2.3.3.6 HOST Selection of HCI-A Interface Parameters (PARM) Message

The "PARM" message may be initiated by the HOST; or it may be a response message to a HCI-A poll.

It is used to select the Interface parameters the HCI-A will use:

a) Operating Mode (NEW, OLD)
b) Start character (SOH, STX)
c) End character (EOT, CR, none)
d) Timeout value, in seconds

Format of the poll and response are shown in Table 2-7.

Table 2-7. HOST Selection of HCI-A Interface Parameters Message Format

HOST POLL HCI-A RESPONSE

STX STX ANLZ ANLZ # PARM OK MODE ETX STRT CKSM1 END CKSM2 SECS * (END) ETX CKSM1 CKSM2

* (END)

NOTES

1 The start character may be either STX or SOH.
2 ANLZ # is defined to be 255.
3 PARM sets the HCIA Interface Parameters, and has a value of 133.
4 MODE, STRT, END, and SECS are the code numbers for the desired interface parameters.

MODE is the desired code for the operating mode (0.0* = NEW, 1.0 = OLD).
STRT is the desired code for the first character of the message (1.0 = SOH, or 2.0 = STX*).
END is the desired code for the last character of the message (0.0*, 4.0 [EOT], or 13.0 [CR]).
SECS is the desired time for Timeout duration, in seconds (valid times are 1.0, 2.0*, 3.0, 4.0, or 5.0).
= default parameters (NEW, STX, no END, 2 seconds timeout).

+ MODE = OLD Mode sends a 'NO more data' message to the HOST after the TOR data, -NEW Mode does not send the 'NO more data' message.

1 OK indicates the message was received and understood, and has a value of 128.
2 The CKSM is 2 ASCII characters.

*7. The END character is selectable by the HOST.

2.3.3.7 HCI-A Request for Interface Parameters (RIP) Message

The "RIP" message is initiated by the HCI-A. It is used to request the operating parameters the HCI-A will use.

Format of the poll and response are shown in Table 2-8.

Table 2-8. HCI-A Request for Interface Parameters Message format

HCI-A POLL	HOST RESPONSE	HCI-A RESPONSE
		STX STX STX ANLZ # ANLZ # ANLZ# RIP PARM OK ETX
		MODE ETX CKSM1 STRT CKSM1 CKSM2 END CKSM2
*		(END) SECS * (END)
		ETX
		CKSM1
		CKSM2
	* (END)	

NOTES

1 The start character may be either STX or SOH.
2 ANLZ # is defined to be 255.
3 RIP requests the Interface Parameters from the HOST, and has a value of 133.
4 PARM sets the HCI-A Interface Parameters, and has a value of 133.
5. MODE, STRT, END, and SECS are the code numbers for the desired interface parameters.
+ MODE is the desired code for the operating mode (0.0* = NEW, 1.0 = OLD).
STRT is the desired code for the first character of the message (1.0 = SOH OR, 2.0=STX).
END is the desired code for the last character of the message (0.0*, 4.0 [EOT], or 13.0 [CR]).
SECS is the desired time for Timeout duration, in seconds (valid times are 1.0, 2.0*, 3.0, 4.0, or 5.0).
*=default parameters (NEW, STX, no END, 2 seconds Timeout).

+MODE - OLD Mode sends a 'NO more data' message to the HOST after the TOR data,

-NEW Mode does not send the 'NO more data' message.

5 The CKSM is 2 ASCII characters.

*7. The END character is selectable by the HOST.

8. HCIA will transmit RIP message three times if there is no response from HOST. After third transmission, HCIA will assume default parameters.

2.3.3.8 HOST Request for HCI-A Status Bits (HRST) Message

The "HRST" message is initiated by the HOST. It is used to request the operating 'status' bits of the HCI-A. This is the information which can be set in response to the HCI-A RIP in the same order. With this message, the HOST can check the parameter setup in the HCI-A.

Format of the poll and response are shown in Table 2-9.

	HOST POLL	HCI-A RESPONSE
	STX	STX
	ANLZ #	ANLZ #
	HRST	STTS
	ETX	STTS1 (MODE)
	CKSM1	STTS2 (STRT)
	CKSM2	STTS3 (END)
*		(END) * STTS4 (SECS)
		ETX
		CKSM1
		CKSM2
		*(END)

NOTES

1 The Start character may be either STX or SOH.
2 ANLZ # is defined to be 255.
3 HRST requests the HCI-A status bits, and has a value of 135.
4 STTS sends the HCI-A status bits, and have a value of 136.
5 The CKSM is 2 ASCII characters.

*6. The END character is selectable by the HOST.

7. The STTS descriptions can be found in the RIP description.

Summary

Message Description Transaction

1 135 Request for HCI 'status' HOST -> HCI bits (HRST) STX ANLZ,135.0,ETX
2 136 Send 'status' bits (STTS) HCI -> HOST STX ANLZ,136.0,stts1,stts2,stts3,stts4,ETX

2.3.3.9 'DAS' Interface Option

The "ENQ/ACK" message format allows the HOST to asynchronously interrogate the HCI-A to determine if it is on-line. The message protocol without the 'CR' parameter is as follows:

a The HOST transmits: ENQX'05' b The HCI-A responds: ACKX'06'

The message protocol with the 'CR' parameter is as follows:

a The HOST transmits: ENQX'05'
CRX'0D'
b The HCI-A responds: ACKX'06'
CRX'0D'

Any INQUIRE message received from the HOST while a transmission from the HCI-A to the HOST is in progress will be ignored by the HCI-A. If the 'CR' parameter is selected, the HCI-A will not regard an INQUIRE message as complete until the 'CR' is received and formed-up inside the interface hardware. Therefore, it is possible that a transmission from the HCI-A to the HOST may begin during receipt of the 'ENQ-CR' from the HOST. In this case, the 'ENQ' message is ignored by the HCI-A.

2.3.4 Message Examples

Examples of TOR, HAE, TAD, RIP/PARM and HRST/STTS messages are illustrated in the following subsections. The types of message sequences which may occur are as follows:

Transmission of results from analyzer (Section 2.3.4.1) TOR (HCI-A), OK (HOST)
[MODE=new] TOR (HCI-A), OK (HOST) NO (HCI-A), OK (HOST)

[MODE = old] Activation of an event by the

HOST or result request (Section 2.3.4.2) HAE (HOST), OK (HCI-A) Event is

activated HAE (HOST), NO (HCI-A) Event is not activated HOST set of analyzer's

time and date (Section 2.3.4.3) TAD (HOST), OK (HCI-A) Powerup request for

operating parameters by HCI-A (Section 2.3.4.4) RIP (HCI-A), PARM (HOST)

HOST inquiry for interface on-line (Section 2.3.4.5) ENQ (HOST), ACK (HCI-A)

2.3.4.1 Example 1 - TOR Message

Example 1 is a Transmission of results on Logical analyzer #1 stream 1. The poll supplies results for 02, N2, and HE from an analysis taken on 6 March 1984. An alarm was currently present at the analyzer. For instance, the reading for 02 is 41.9%.

Table 2-10. Example of a TOR Message Sequence

HCI-POLL

STX	ANLZ#	TOR	RSLT1 Time of Day
02	1.0, 312E302C	130.0, 3133302E302C	1612.0, 313631322E302C
RSLT 2 Day of Month 6.0, 362E302C	RSLT 3 Month 3.0, 332E302C	RSLT 4 Year 87.0 38372E302C	RSLT 5 Stream # 1.0, 312E302C
RSLT 6 Anlz # 1.0, 312E302C	RSLT 7 Anlz Status 1.0, 312E302C	RSLT 8 Alarm Code 130.0, 3133302E302C	RSLT 9 02 41.9, 34312E392C
RSLT 10 N2 4.47, 342E34372C	RSLT 11 HE 23.8, 32332E382C	ETX 03	CKSM DF 4446

(END)

HOST RESPONSE

STX	ANLZ#	OK	ETX
02	1.0, 128.0, 312E302C	3132382E302C	03
CKSM E5 4535*	(END)		

NOTE

*The END character is selectable by the HOST.

When MODE = old, additional TOR/OK messages may occur until all results are transmitted for the stream, at which time a NO/OK sequence will occur.

2.3.4.2 Example 2 - HAE and HRFR Message

Example 2 contains a request for automatic calibration of analyzer # 137. The code of 17 is determined by the particular application.

Table 2-11. Example of an HAE Message

HOST POLL

STX	ANLZ#	HAE	EVENT#

1.0, 131.0, 32.0,
312e302C 3133312E302C 33322E302C

STREAM# ETX CKSM (END)
1.0, 8A 89
312E302C 03 3839 *

HCI-A RESPONSE

STX ANLZ# OK ETX 1.0, 128.0, 312E302C 3132382E302C 03

CKSM (END)
E5
4535 *

NOTE

*The END character is selectable by the HOST.

A "HRFR" request contains event #32 and the stream number of the desired stream results. Subsequence to this transaction, a TOR message will be generated by the analyzer.

Intervening transactions may occur between these two transactions.

2.3.4.3 Example 3 - TAD Message

Example 3 shows the TAD message. The message updates all attached analyzers' clocks.

Table 2-12. Example of a TAD Message

HOST POLL

STX	ANLZ#	TAD	Month
	255.0,	132.0,	11.0,
	323535E302C	3133322E302C	31312E302C

Day of Month Year Day of Weeks Hour 4.0, 84.0, 6.0, 13.0, 342E302C 38342E302C 362E302C 31332E302C

Minute Second ETX CKSM 15.0, 32.0, 78 31352E302C 33322E302C 03 3738

(END)

*

HCI-A RESPONSE

STX ANLZ# OK ETX 255.0, 128.0, 02 3235352E302C 3132382E302C 03

CKSM (END)
50
3530 *

NOTE

*The END character is selectable by the HOST.

2.3.4.4 Example 4 - RIP/PARM Messages

The PARM message may be a response from the HOST (to a RIP message, as illustrated); OR it may be initiated by the HOST (with an OK response message from the HCI-A).

Example 4 is an example of the HCIA requesting its operating parameters.

Table 2-13. Example of a RIP/PARM Message Sequence

HCI-A POLL

STX	ANLZ#	RIP	ETX
	255.0	134.0,	
	3235352E302C	3133342E302C	03

CKSM (END)
4D
3444 *

HOST RESPONSE

STX ANLZ# PARM MODE 255.0, 133.0, 0.0, 3235352E302C 313333E302C 302E302C

STRT END SECS ETX
2.0, 0.0, 2.0,
322E302C 302E302C 322E302C 03

CKSM (END)
38
3338 *

NOTE

*The END character is selectable by the HOST.

2.3.4.5 Example 5 - HRST/STTS Messages

The HRST message is used to request from the HCI-A its operating 'status' information. The STTS message is used to transmit that 'status' information to the HOST.

Example 5 is an example of the HOST requesting the status information.

Table 2-14. Example of a HRST/STTS Message Sequence

HOST POLL

STX	ANLZ#	HRST	ETX
	255.0,	135.0,	
02	3235352E302C	3133352E302C	03

CKSM (END)
4E
3445 *

HCI-A RESPONSE

STX ANLZ# STTS STTS1 255.0, 136.0, 0.0, 3235352E302C 3133362E302C 302E302C

STTS2 STTS3 STTS4 ETX
0.0, 0.0, 4.0,
302E302C 302E302C 342e302c 03

CKSM (END)
3B
3342 *

(END)

*

NOTE

*The END character is selectable by the HOST.

2.3.4.6 Example 6 - Inquire Message

The HOST may poll the HCI-A to see if it is online with the following example:

HOST POLL

ENQ (END)

05 *

HCI-A RESPONSE

ACK (END)

06 *

Section 3. Computer Communications Protocol (HCI-H)

Contents

3.1 Purpose

This manual provides detailed information about the hardware and software protocol required to interface a computer or other programmable device to the Advance Analyzer system. Such a connection between an external computer and the Advance system is via a serial, digital communications link. Such a connection is presumed to be for the purpose of allowing Advance analyzers to transmit the results of chromatograph analysis to the external computer and to allow the external computer to perform certain control operations of the Advance analyzers.

3.2 Definition of Terms and Reference Information

Terms and Reference Information

The terms "chromatograph", "analyzer", "analyzer system", and "Advance" will be used synonymously to indicate a unit or a system of gas analyzers supplied by Siemens Applied Automation, Inc..

The terms "HOST" and "computer" will be used synonymously to reference a computer or other device external to Siemens Applied Automation, Inc. OPTICHROM ADVANCE® hardware. It is presumed that it is desired to transmit measurement information from Advance to the HOST. Further, in this particular protocol, it is assumed that the HOST is implemented via a "gateway" device which permits the HOST computing system itself to be a system of distributed hardware. However, details of HOST structure are not covered here.

The terms "Result", "Buffer", and "Factor" refer to tabulated items of data or other information that exists in the Advance analyzer system. In general the term "Result" is reserved for one item of measured data which is ready for transmission to the HOST. A "Result" usually corresponds to a "process variable" in HOST programming.

Such a data item can represent any desired item of information such as a measured value, a concentration range upper limit, a time or a date. In addition, so far as Advance sees it, items of information used by the HOST for validation of data are also "Results". Such items include analyzer status and stream status information.

This document is supplemental to Siemens Applied Automation, Inc. publication "OPTICHROM ADVANCE® System, Product Descriptions, HOST Computer Interface, Hiway Protocol (HCI-H)" and to standard manuals published by

Siemens Applied Automation, Inc. in support of the OPTICHROM ADVANCE® System. These manuals include as a primary reference the Application Modification Manual which describes the application programming language available to users.

Additionally, this document references publications by others. These include:

"Peripheral System to Regulatory Control System Communication", March 12, 1984. R. J. Lasher, Exxon Chemical Company, Florham Park, N.J.

"Analyzer/Control System Gateway Data Transfer Specification", January 3, 1985. R. J. Lasher, Exxon Chemical Company, Florham Park, N.J.

"Standard Intersystem Interface Manual" for TDC-3000 Generic Gateway, Rev. 0, April 25, 1985, Honeywell Corporation, Phoenix, AZ.

3.3 Features and Capabilities

This protocol provides methods for the following functions to be implemented.

3.3.1 System Size

* 247 Maximum number of Advance analyzers that can be connected via a single link to the HOST.
* Maximum number of process streams per analyzer for which data can be transmitted to the HOST.

29 For the first 50 analyzers.
1 For the next 197 analyzers.

Note: These limits are interactive. This is further explained below in sections on "Analyzer Rollover."

* 9 Maximum number of components per stream. See the section on alternate maximums on page 40.

This limitation is without rollover for more than 9 comp. Per stream. See the section on alternate maximums on page 40.

3.3.2 Component Values

* 1/65,534 Resolution of the fraction of range in which component values are transmitted. This value may be limited by the user to a smaller number; 1 part in 9999 or 1 part in 4095 are commonly used in some HOST hardware configurations.
* unlimited Absolute maximum component "full scale" value - "EUHI". Floating point notation available for component range specification; adjustable by user.

Note: Component values are transmitted as a fraction of an assumed "full scale" value; that is to say, the component values are not transmitted as absolute numerical values. As noted above, the maximum value of the fraction - and therefore the resolution of the data transmission - may be specified by the user via the Advance User Service Panel. This full scale value is called "EUHI" which is "Engineering Units, High."

The "full scale" value may be any desired number but is assumed to be the same value in the HOST and in the Advance analyzer. The "full scale" value is in fact a number, individually specified per component, which must be entered into the Advance analyzer by the user via the Advance User Service Panel.

Note, the low end of component range is always assumed as 0.

Example: If component full scale is specified by the user as 25 mole %, and the maximum fraction value is specified by the user as 9999, then a component value of:

9999 implies 9999/9999 * 25% equals 25 % and 5000 implies 5000/9999 * 25% equals 12.5 % and 250 implies 250/9999 * 25% equals .625 %

Example: If component full scale is specified by the user as 200 parts per million, and the maximum fraction value is specified by the user as 4095, then a component value of:

4095 implies 4095/4095 * 200ppm equals 200 ppm and 2048 implies 2048/4095 * 200ppm equals 100 ppm and 150 implies 150/4085 * 200ppm equals 7.326 ppm

3.3.3 Data Validity and Operational Checks

1. Analyzer Operation

Each analyzer is continuously monitored for its operational status and status information is reported to the HOST. Operating information available for HOST use is as follows. (See also further information in the next two subsections, 3.3.4, "Information Available to the HOST" and 3.3.5, "HOST Controls on Advance Analyzers".)

Normal operation, reporting data on schedule.
Calibration operation.
Manual operation.
Current stream in analysis.
Operating on a particularly selected stream (if true).
Skip/Run status of all defined streams.
Analyzer out of service and not transmitting.

2. Analyzer Programming

Certain parameters in analyzer programming are continuously checked to determine if they have been changed from one analysis cycle to the next. Analyzer programming is generally accessible to analyzer maintenance personnel. It is presumed desirable to verify that certain aspects of analyzer programming which might affect data reported to the HOST are not changed without HOST knowledge.

2 Component Validity

Each component measured can be checked as follows:

Rate of change. Component is checked to verify it does not change too greatly from one analysis cycle to the next.

Minimum change. Component can be checked over a period of multiple analysis cycle to verify that it does change by some amount. It is presumed that in a real process situation, if a component value never changes, something is wrong. User selectable minimum change value and number of cycles in check period.

User selectable rate of change limit. (This particular validity check may be blocked by explicit HOST action as described further below.)

3.3.4 Information Available to HOST from the Analyzers

1. Component Values

Expressed as a fraction of full scale for each process variable. This is the primary analysis information that is measured by the Advance analyzers.

A value of 65,535 - which exceeds any allowable full scale - is reserved to indicate to the HOST that the measured data is bad. This value is assigned whenever any of the "Data validity and operation checks" described in the previous section suggests that component values are faulty and not of value to the HOST.

2. EUHI - Engineering Units, High

This is the full scale value for each component. It is the value currently being used by Advance to calculate the component value; expressed as a 2 byte floating point number. (Please see Appendices and further information in

following sections.)

This value is useful to the HOST if the HOST programming permits verification that the full scale value in use by the analyzer system matches the full scale value in use by the HOST itself. (Refer to information in the previous section, 3.3.2)

Additionally, as further described below, the value can be written by the HOST to the analyzers to force synchronization. When this is done, the HOST effectively overwrites any full scale value which analyzer maintenance personnel may have entered by hand via the Advance User Service Panel.

3. Data "Read Me" Flags

A binary status flag for each stream of each analyzer is maintained by the Advance. These flags may be scanned by the HOST as a means of determining that new component data is available. The flags are set by the Advance any time new data becomes available and each is reset by the Advance automatically after having been read by the HOST.

It is not required that these flags be used by the HOST. All component values are always continuously available and are continuously maintained with currently available data. These component values may be read at any time by the HOST and as often as desired.

4. Stream Skip Status Flags

A binary status flag for each stream of each multiple stream analyzer is maintained by the Advance. These flags continuously indicate current stream skip information about each analyzer. That is, on those analyzers which are applied to measure multiple process streams, these flags indicate which of those streams are turned on and which are turned off.
These flags are normally set and reset as a result of manual direction by analyzer maintenance per sonnel. In this case, the flags may be regarded as information to the HOST. Additionally, these flags may be written to directly by the HOST. When this occurs, the Advance analyzers are forced into the state that the HOST directs; that is the HOST may force individual streams to be skipped or to be run.

5. Stream Select Flags

A binary status flag for each stream of each multiple stream analyzer is maintained by the Advance. The flags indicate that a specific stream on multiple stream analyzer is selected to run continuously. If a Stream Select Flag is set, it supersedes the Stream Skip Status Flags; that is only the selected stream will run, regardless of Stream Skip Flag indications.

These flags may be set as a result of manual direction by analyzer personnel. In this case, the flags may be regarded as information to the HOST. Additionally the flags may be set by the HOST. When this occurs, the analyzer will begin to analyze the selected stream as soon as is physically possible.

6. Stream Active Flags

A binary status flag for each stream of each multiple stream analyzer is maintained by the Advance. The flags indicate that analysis is currently in progress on the indicated stream. The flags are mutually exclusive; that is, only one stream per analyzer may be active at any one time. The flags are intended only to provide information to the HOST.

7. Analyzer in Standby Flags

A binary status flag for each analyzer is maintained by the Advance which indicates that the analyzer is not currently active. This flag may be written to by the HOST to force the analyzer to go into a standby mode. Such action is not required; the HOST may ignore this bit entirely and allow manual direction to prevail.

8. Analyzer Operating Status

A numerical value is maintained by the Advance for each analyzer in the system. These values can range from 0 to 1000 and continuously provides a qualitative statement of the operating status of each analyzer. That is, an analyzer for which this value is 1000 is operating correctly and normally.

9. Data Base Change Flags

A binary status flag is maintained for each stream of each analyzer in the advance system which can be used to indicate to the HOST that some item or items in the corresponding analyzer has been changed. Typically, such changes are the result of manual intervention by analyzer maintenance personnel. Action that should be taken if this occurs is left to the discretion of the HOST and the user. The flags remain set until explicitly reset by the HOST. It is not required that the flags be used.

2 EUHI Change Flags

A binary status flag is maintained for each stream of each analyzer in the advance system which can be used to indicate to the HOST that the EUHI (component "full scale") value in use by the analyzer for one or more components has been changed. These flags are exactly equivalent in operation to the "Data base change flags" described above. However, the EUHI change flags are specific in that no item in analyzer programming is checked for change except the EUHI values. Again, these flags are provided for user convenience and information only; it is not required that they be used by the HOST.

3.3.5 HOST Controls on Advance Analyzers

Methods are provided by which the HOST can pass certain information to Advance analyzers and by which the HOST can direct various actions to occur in the analyzer system.

1. Analyzer Control

The HOST is allowed to direct individual analyzers to stop running - that is to go into a standby mode -and later to resume running normally. See also the previous subsection, 3.3.4, item 7.

2. Calibration Control

The HOST is allowed to direct individual analyzers to calibrate. A binary status flag for each analyzer is maintained by the Advance which is associated with analyzer calibration. These flags may be written to by the HOST. When this occurs, the analyzer is forced into calibration. Such action by the HOST is not required; these flags normally represent the status of the analyzer that results from manual direction.

The HOST may read these flags. If this is done shortly after the HOST has set the flag to direct the analyzer to calibrate, the flag will still be set. At some later time when calibration is complete, the flag will be reset. Note however, if calibration is initiated manually by analyzer maintenance personnel, this flag will not indicate that is occurring. See instead the description of the analyzer status.

3. Stream Control

On multiple stream analyzers, HOST is permitted to direct that

a. individual streams be skipped or allowed to run normally.
b. specify a particular stream to be run continuously.

Reference also the previous subsection, 3.3.4, items 4 and 5.

4. Maximum Rate of Change Test Enable/Disable

A binary control flag is provided for each individual stream for each analyzer in the Advance system that controls the applications of the "Maximum rate of change test" that is applied to individual components. It often occurs during process upset or plant startup conditions that component concentrations vary widely. In these situations it is possible for HOST programming to direct the Advance system not to flag such deviations as bad. By writing to this flag, the HOST can enable or disable this test. It is not required that the HOST use this feature.
A separate binary flag is provided for each individual stream in the system. However, additional flags are provided that control entire multiple stream analyzer and a single additional flag is provided that controls the entire system. Therefore, the HOST may disable maximum change on the entire chromatograph by simply writing to a single flag location (as described further below). It is not required that the HOST use this feature.

5. Force EUHI

A method is provided by which the HOST can specify the EUHI - Engineering Units, High - value which is in use by the analyzers. Normally, this value is loaded manually by analyzer maintenance personnel via the Advance user service panel. However, the HOST can write this value, if it is possible in HOST programming, thereby ensuring that the Advance analyzer and the HOST are using the same assumed component full scale value. It is not required that the HOST use this feature.

6. Set Real Time Clock

By writing to appropriate locations, the HOST is permitted to set the real time clocks in Advance analyzers. It is not required that the HOST use this feature.

2 HOST Alive

A binary flag location is provided for the HOST to indicate that the HOST is "alive" to the analyzer system. This location is a "watch dog" or "dead man" timer location. The HOST must set this location every 15 seconds or more often or the Advance analyze system will presume the HOST is not operating. Advance response in this case is not defined in this specification; several actions are possible and are defined by specific application requirements.

This feature must be used by the HOST.

3.4 Hardware Protocol

3.4.1 Background Configuration of Advance System

The Advance analyzer system consists of multiple individual pieces of hardware each performing various functions and each interconnected by means of a "Data Hiway" type communications cable. It is as a result of the Data Hiway, that collectively, the various pieces of hardware are referred to in this manual as a single "system". In any given application, there may be a different number of pieces of hardware in the system. In any application involving the computer link protocol described in this manual, there are a minimum of two primary units attached to the Data Hiway; these two units are one analyzer and the interface to HOST. Some applications may have up to 255 units attached variously to the Data Hiway.

The most significant hardware item - that is "unit" on the Advance Data Hiway - is the "analyzer". This is the primary measurement device that provides the analytical information for which the system exists. In all communications with HOST, data is identified as originating with a particular analyzer. Since the analyzer is typically a chromatographic instrument, each analyzer is capable of providing concentration information about more than one component in the process. Therefore, each analyzer typically provides information about multiple "process variables" to the HOST. Additionally, some of the analyzers in turn are used to perform analysis on product at more than one point in the process - that is on multiple process streams. When this occurs, each analyzer provides multiple sets of component information to the HOST.
Therefore, individual component information, that is each process variable, is identified by a hierarchy of numbering as follows.

1st Analyzer
2nd Stream
3rd Component

For example, the methane composition at a particular point in the process may be identified as

Component 3
of Stream 1
of Analyzer 19.

It should also be noted that many items of analyzer operation status are also stream dependent. For example, the "Run/Skip" status flag described above is associated with a particular stream. Therefore, on a multiple stream analyzer, there is one such flag per stream. However, other data is not stream dependent. For example, the "Analyzer Hold/Normal Run" flag described above pertains to the analyzer itself. For such data, there is only one flag provided per

analyzer. More detail in each specific case is provided below.

Example Message

Message to set coil 00009 (HOST alive coil).

NOTE

This coil must be set by the HOST at least once every 15 seconds for the Advance System to consider the HOST alive and operating. If it is not set the Advance analyzers generate user alarms.

HOST Poll		HCI-H Response	
01	HCI-H		
05	write to coil		
00	coil 9		
08			
FF	coil "on"		
00			
0D	crc		
F8			
		01	HCI-H unit
		05	echo of write to coil
		00	echo of coil written
		08	
		FF	echo of coil "on"
		00	
		0D	crc for message (not an echo; match in this case only.)
		F8	

NOTE

This example assumes HCI-H strapped for HOST Link unit 1.

Coil 9 is external referred to throughout this specification. Actual transmission (i.e. "internal reference") is coil and register number less one. Hence, this example, Coil 00009 is addressed as Hexadecimal '0008'.

Coil "on" command is X'FF00'. Coil "off" command would have been X'0000' but then also note the resulting crc characters would have been different.

General

This manual provides design information for the Advance System Option "HOST Computer Interface, Hiway Protocol". This design information covers the HCI-H interface hardware and firmware and it covers appropriate portions of application level programming for Advance analyzers in systems in which this option is used. The information provided here is supplement to other documents as noted next.

Limitations

As implemented in the Advance Analyzer System, certain limitations are imposed on analyzer configurations and the amount of data that may be transferred from Advance to the HOST. These limitations are as follows:

Maximum Number of Advance (HCI-H) systems which may be connected to a single HOST by common transmission lines = 1. The following limitations are specified "per Advance (HCI-H) System".

Maximum Number of Chromatographs = 247 (numbered from 1 through 254.)
This limitation is based on 31 units per loop and 8 loops per system. This yields a maximum of 248 units with one unit being the HCI-H interface. This leaves 247 units available which may be chromatographs.

Maximum Number of Streams per Analyzer:

Analyzers 1 to 50, = 9 streams <u>see Alt. maximums below</u>

Analyzers 51 to 254 = 1 stream

Maximum number of components per stream:

Analyzers 1 to 50 = 254 comp. <u>see Alt. maximums below</u>

<u>Alternate Maximums</u>:

Analyzers 1 through 50 may exceed 9 streams per analyzer and/or may exceed 9 components per stream. If this is done, there is a net reduction in the total number of analyzers that may be used on the system;
e.g. If Analyzer #2 exceeds the comp./strm limit it uses space in STRM #2 for STRM #1 RSLTS. STRM #2 then uses memory locations for STRM #3 and #4.

If ANLZ #2 exceeds the STRM limit it uses ANLZ #3's memory locations for its STRM #'s greater than 9. ANLZ 3 cannot exist if any of its space was used by ANLZ #2.

<u>Note on Maximum Value 9</u>

This limit may be set to 8 streams and 8 components by a hardware strap option. Such a limitation is desirable when interfacing to some manufacturers of HOST computing equipment.

The following limitations apply to all data transmitted via this protocol.

All data is transmitted with 16 bits (1 part in 65,535) resolution, regardless of the resolution of the actual measurement. Measured data is transmitted as a percentage of a specified full scale value.

All data is transmitted unsigned. Negative data items may not be transmitted directly; if a data item is intended to be negative, this must be understood and compensated for by HOST programming external to this protocol.

NOTE

These limits are not implied by Advance hardware constraints but are implied by constraints of this protocol and equipment for which this protocol is intended.

Advance Hardware Features and Indicators

1 The Advance system will interface via an advance computer interface board model HCI-H coupled with an interface memory expansion board model HCI-H Memory Add-on.
2 The HCI-H occupies one unit number position on the Advance Data Hiway and causes the entire Advance system to appear as one system number to the HOST.
3 The pair of boards, HCI-H and HCI-HMA utilizes firmware resident in up to 32 k-bytes of PROM and manipulates data in up to 80 k-bytes of RAM. Neither firmware nor RAM utilization is user adjustable.

4. The board performs several self diagnostic tests on power up. In addition there are indicator lights on the board which indicate normal and abnormal operation. Following is a summary of the self-diagnostics and the indicators.

a. The board tests hardware associated with its own microprocessor including the RAM, PROM, hardware timers, Advance Data Hiway communications (both channels) and RS-232 communications channel to the HOST. In addition, all indicator lights are flashed for a visual check. The board goes to an inactive state ("Listen Only Mode") if the processor or related components fail.

b. The board indicates via lights on the front the failure of any portion of the above tests. Specific diagnostic indications that occur on power up or software reset will verify:
incorrect Advance unit number strapping,
failure of the processor, RAM, or PROM.
Failure of Advance Data Hiway, either path.

These tests are performed periodically until communication is verified with the HOST. If any test fails, the HCI-H enters a "Listen Only Mode" in which it cannot make transmission to the HOST. In this mode, the Advance HCI-H listens for communications from the HOST but never makes any transmission in response. The Advance HCI-H remains in this Listen Only Mode until specifically reset by command from the HOST or until it is reset manually.

c. In normal operation the lights indicate:
HCI-H self-test in progress
RAM and PROM and other HCI-H hardware failures

Advance Data Hiway failures
Invalid analyzer numbering on the Advance Data Hiway.

1 The board is physically isolated from the HOST communication lines by relay contacts that are open except when the HCI-H is going to transmit to the HOST. This relay isolation may be bypassed if the Advance HCI-H is the only unit in communication with the HOST in a particular installation.

6. The boards accommodate strapping in the hardware to permit field selection of the following parameters.

a. Communication baud rate to HOST;
9600 baud is default standard. Other standard, slower, baud rates are available.

b. Advance system address number as visible to HOST; System Number 1 is default standard. Other system numbers from 0 through 255 are available. Desired system address is specified on a "per system" basis by HOST applications personnel.

c. Maximum number of streams and components allowed on individual analyzers as visible to HOST; 9 is default standard. See the previous section of "Limitations". Optionally available is 8. Required strapping is specified by HOST applications personnel.

d. Advance System Loop and Unit Number selection as visible to Siemens Applied Automation, Inc. supplied analyzers and equipment. The Loop number is fixed at 1. The unit number varies from 1 to 31. The numbers required in a particular installation are specified by Siemens Applied Automation, Inc. analyzer applications personnel and are documented in appropriate Siemens Applied Automation, Inc. manuals or custom system documentation.

Conventions and Interface Requirements

1. All communication is bit serial, byte oriented with bytes being structured as:

   1 start bit
   8 data bits
   1 parity bit (odd), and
   1 stop bit.

   This configuration is not changeable.

2. Hardware protocol is Electronic Industries Association standard RS-232-C, Interface Type D. As discussed in reference documentation, a 4-wire type connection is supported. This is:

   Transmit
   Receive
   Ground (for each of above).

Other hardware formats discussed in reference documentation are not supported in normal utilization.

Message Structure

All messages between the HOST and the Advance system have the same structure. The HOST always initiates information exchange. The Advance system responds to some messages from the HOST. This is further explained below.

The basic message structure is as follows: HOST sync time, Advance system address,

Function Code, Data bytes as needed,..., CRC error checking HCI-H sync tim, Advance

system address (self), Function code (echo), Data bytes as needed, CRC error

checking A more detailed definition of each of the items listed is provided next.

ITEM	MEANING
Synchronization	A time interval (further detailed time below) which indicates start of messages.
Address	The Advance System Number as desired by the HOST and established by strapping in Advance Hardware, Address numbers range from 0 to 255.
Function	A function code specified by the HOST which indicates to the Advance System the type of message or information that the HOST desires to have. Values allowed from the HOST are 1 through 6, 8, and 102.
Data	A value determined by the HOST or Advance (whichever is sent which conveys information desired. Values range from 0 through 255 although all data items consist of two consecutive bytes; therefore data range is actually 0 through 65,535.
Data Data Data	Repeat as required for message.
CRC 1 CRC 2	Cyclic Redundancy, Error Check, 1st portion. Cyclic Redundancy, Error Check, 2nd portion. Note: This method of error checking is more fully described in an appendix to this paper.

As noted above, all messages follow this same structure, whether the message is transmitted by the HOST or by the Advance system. Most message exchanges consist of two parts:

1) The HOST transmits a poll message to the Advance, and 2) The Advance transmits a response message to the HOST.

Some messages consist of only one part. These are:

a. A transmission by the HOST in which the Address field is set at 0. No Advance system will respond to such a message, even if its own address number set in its hardware strapping is 0. All Advance systems which hear such a message may take some action as required by the message regardless of their own address number.

b. A transmission by the HOST in which there is some transmission error. Such

errors are parity, framing, or overrun. No Advance system will respond to such a message. Any Advance system which hears such a message will increment a counter it maintains which counts such bad transmissions. This if further detailed in a later section of this manual.

There are certain conventions which are followed by Advance and are expected to be adhered to by HOST.

1. The Address field in a message from the HOST is determined by the HOST based on the address of multiple possible Advance systems it wants to access.

   The Address field in a message from the Advance is always its own address as set into its hardware
   strapping.

1 The Advance system never originates a message unless it has just received a message from the HOST containing the Advance systems address as set into its hardware strapping.
2 The synchronization time indicated in the message structure is preserved by all senders to be a minimum of 3 character times at the baud rate selected by hardware strapping. That is, no sender of a message (either HOST or Advance) will originate a transmission unless it has confirmed a period of no activity on the communication lines that has lasted at least 3 character times. Therefore, any device attached to the communication lines - either HOST or another Advance system may use the synchronization interval as a "start of message" indication. If HOST does not allow the necessary time interval to occur, Advance may never respond.

NOTE

> All items of transmission are binary and no protocol characters are reserved. Therefore, the
> synchronization time is the only available indication of start of message.

Function Codes and Data Fields

The function codes and the data fields of the message structure identify the intent of the message and carry any data that pertains to the particular message. The various possibilities are described here.

NOTE

> The descriptions which follow will often refer to "Data Address". This references data that is measured or provided by one or more Advance analyzers. The structure of this "data address" is detailed in a later section of this paper entitled "Data Address Structure."

All function codes are selected by the HOST depending on what it wishes to accomplish with its message. The function code selected is echoed by the Advance in its Response to the HOST Transmission. Only certain functions codes are allowed. These are (Hexadecimal values): 1,2,3,4,5,6,8, and 66.

All other values are illegal and handled as described later. Provided next is a detailed explanation of the meaning of each function code. Note that the abbreviations "M.S." and "L.S." will refer to the Most Significant" parts or bytes respectively.

Host Read from HCl-H

FUNCTION	DESCRIPTION
X'01 X'02	HOST wishes to obtain digital status from one or more analyzers.
X'03'	HOST wishes to obtain analog information (typically measured data) from one or more analyzers.
--HOST Transmission-	
M.S. Data Address L.S. Data Address	Data address of desired status.
M.S. No. Data Items L.S. No. Data Items	Number (count) of sequential items of desired data beginning at the specified Data Address.
--Advance Response-	
Byte Count	Number of bytes of data that are being transmitted excluding this "Byte Count" byte.
1st data byte	Bytes which contain the data item which were requested by the HOST. If the data is digital status information, it is packed into the Data Item bytes as described below (section title "Notes on Data Field"). If the data is analog information such as component measurements it is transmitted as two bytes of data per item.
2nd data byte	
3rd data byte	
etc. as required	

Host Write to HCl-H

FUNCTION	DESCRIPTION
X'05'	HOST wishes to send digital status information to one or more analyzers.
X'06' X'66'	HOST wishes to send analog information (typically component ranges) to one or more analyzers.
--HOST Transmission-	

M.S. Data Address L.S. Data Address	Data Address of status bit being transmitted.
1st data byte	If this is digital data, X'FF' sets status bit ON and X'00 sets status bit OFF. If this is analog data, this is M.S. byte.
2nd data byte	If this is digital data, this byte is always X'00'. If this is analog data, this is L.S. byte.

--Advance Response-

Identical to "HOST Transmission" above if the Advance was able to correctly perform the action that was requested.

HOST Performs Diagnostic Testing of Communications Link

FUNCTION DESCRIPTION X'08' HOST desires to perform "loopback" diagnostic testing of the HCI

H communications interface. --HOST Transmission-Zero byte Byte is always X'00'

Diagnostic Code Byte is X'00' or X'01' --Diag. Code=X'00'-Test data byte Random data of HOST selection

Test data byte Random data of HOST selection --Diag. Code=X'01'-Diagnostic Control Byte is X'00'

See explanation below in section "Notes on Data Field" for appropriate meaning. Zero byte Byte is always X'00'.

EXCEPTION Responses

These FUNCTION CODES are used by the Advance in response to a HOST Transmission if the Advance detects any of a variety of errors in the HOST Transmission. See the section below entitled "Advance Exception Responses".

FUNCTION DESCRIPTION

X'80' Valid Exception Code = 1 X'81' Valid Exception Codes = 2, 3 X'82' Valid Exception Codes = 2, 3 X'83' Valid Exception Codes = 2,3 X'84' Valid Exception Codes = 2, 3 X'85' Valid Exception Codes = 2, 3, or 4 X'86' Valid Exception Codes = 2, 3, or 4 X'87' Valid Exception Code = 1 X'88' Valid Exception Code = 3

X'89' Valid Exception Code = 1 : X'E5

X'E6' Valid Exception Codes = 2, 3, or 4

X'E7' Valid Exception Code = 1 : X'FF'

NOTE

These are each considered an invalid FUNCTION CODE from the HOST.

--HOST Transmission

Never.	This should never occur. These FUNCTION CODES are invalid for HOST transmission.

--Advance Response-

Exception Code	A single byte of data is transmitted here which gives diagnostic information about the error detected by Advance. See section "Advance Exception Responses" for further explanation.

Broadcast Messages

The Advance system will accommodate a transmission to system address number '0'. If this occurs, no Advance system will respond. However, any Advance system hearing the message will take action as directed by the message.

In this case, only three of the function Codes listed above will be considered valid. These are X'05', X'06', and X'66'. Any message to system address number "0" with any other function Code will be ignored.

Notes on Data Items

1. Data Address

Function codes X'01' through X'06' and X'66' refer to a "Data Address". This is the location in the memory of the Advance HCI-H that contains the actual status or analog information that is desired by the HOST. All available memory is addressable by two bytes. The actual memory map and memory addresses required to access different analyzer status and measurement information is detailed in a later section entitled "Data Address Structure".

2 Number of Data Items

In Function codes X'01' through X'04', the HOST has the option of obtaining one or more bytes of analyzer information from the Advance HCI-H with a single message. As will be detailed below in the section on "Data Addressing", all analyzer information is arranged in HCI-H memory in such a manner as to make it convenient for the HOST to obtain multiple items of related information via a single read. This arrangement is based upon common programming which is used in HOST machinery made by various manufacturers using gateway devices of the type for which this Advance Communications Link is intended.

If the Number of Data Items specified is one, the HOST will obtain only the information at

the Data Address specified. If the Number of Data Items specified is more than one, the HOST will obtain information from immediately sequential Data Addresses.

If the number of Data Items specified would carry the HCI-H into an invalid Data Address location, the HCI-H will respond with an exception message as described above.

3. Byte Count

In most message transmissions from the Advance, the data supplied will be in response to a HOST Transmission requesting the data. Since the HOST can request more than one Data Item, the length of the Advance Response transmission can vary. This byte Count is used to indicate the length of the message.

2 Data Bytes

In messages from the Advance which are in response to HOST Transmission with Function Codes X'0' through X'04', the Advance will be supplying data requested by the HOST. The data supplied is packed into consecutive bytes in the Advance Response transmission.

If the data is analog in nature - such as a status bit or flag bit indicating operating conditions in an analyzer - the data is transmitted as the Least Significant Bit in one byte of data. If only one status bit has been requested by the HOST, only one data byte is transmitted and higher order bits are set to "0". If more than 8 status bits are requested, the 9th status bit becomes the L.S. Bit in the second data byte and the 16th status bit becomes M.S. Bit in the second data byte. For example, if 11 bits of status information have been requested from the HOT, two Data Bytes will be transmitted with the arrangement as shown here:

First Byte Second Byte
Bit 7 0 70
XXXX XXXX 0000 0XXXX

: :...1st :...11th
:.....…….8th

5. Diagnostic Bytes

For test purposes, the HOST has the option of placing the Advance HCI-H in a special hardware verification mode. When in this mode, the Advance response transmissions do not relate to actual analyzer data in any way. Rather, the response is controlled by the HOST.

When the Function Code is X'08', the first data byte must be X'00' and the second - the Diagnostic Code - may be X'00' or X'01'. Any other combination will be interpreted as illegal by the Advance and an exception response will ensue.

If the Diagnostic Code is X'00', the two data bytes that follow may be random as desired by the HOST. But if the Diagnostic Code is X'01', the two bytes that follow are specified. The Diagnostic Control Byte must be X'00' and the next byte must be X'00'. Any other

combination will be interpreted as illegal by the Advance and an exception response will ensue.

Further information on the actual actions taken by the Advance HCI-H when commanded into this diagnostic mode are discussed below in the section entitled "Loopback Diagnostic Testing".

Advance Exception Responses

On occasion the Advance HCI-H may detect an error of some form in a message received from the HOST, when this occurs the Advance will do one of three things:

1 If the Advance HCI-H was unable to interpret the message due to hardware errors in the communication because of parity, framing, or overrun, or if the HCI-H is unable to verify correct checking in the CRC characters, the HCI-H will take no further action.
2 If the message was directed at another Advance System Address other than the one for which the HCIH is strapped, the HCI-H takes no action.
3 If the message was directed at the Advance System Address for which the HCI-H is strapped but contained an invalid Function Code or any Data Item which is invalid as described above, then the Advance HCI-H generates an Exception Response Message.

NOTE

If the Advance HCI-H is in its Listen Only Mode it makes no response under any error condition.

The format of the Exception Response Message is described above. What follows is the meaning of the Function Codes and Data Items that might be used.

In general, the Advance returns as the Function Code in the Exception Response Message the same Function Code that was used by the HOST in the preceding HOST Transmission message with the M.S. Bit of the Function Code set. That is, the Function Code is incremented by X'80'. Therefore, one valid Exception Response Function Code exists for each valid Function Code that might be received from the HOST.
Note that all of the Exception Response Codes are themselves invalid in a HOST transmission.

When the Advance makes an Exception Response Transmission, there is a single Data Byte which follows the Function Code. That Data Byte has the following meaning.

CODE	MEANING	DESCRIPTION
X'01'	Illegal function	The message function received is not an allowable function.
X'02'	Illegal Data Address	The address referenced in the data field is not an al lowable address.
X'03'	Illegal Data Value	The value referenced in the data field is not allowable; or the number of data items specified would require referencing an invalid data address.
X'04'	Failure in Advance	There is some failure in the Advance System that pre

vents completion of the desired action.

Loopback Diagnostic Testing

As indicated above, if a HOST Transmission is received in which the Function Code has a value X'08', the HCI-H performs Loopback Diagnostic Testing. The actual actions taken by the HCI-H are described in this section.

1. In a HOST Transmission, when the Diagnostic Code is set at X'00, the two bytes that follow are considered by Advance to be test data supplied by the HOST. As far as the Advance HCI-H is concerned, the values may be random. Both data items are reflected in the Advance Response Message which is returned to the HOST. This is intended to allow the HOST to generate test patterns that confirm data integrity.

An entire transaction of this type consist only of the one HOST Transmission and the required Advance Response. Any subsequent messages are interpreted by the Advance HCI-H as new information - not necessarily additional testing efforts.

2 If the Diagnostic Code in a HOST Transmission is X'01', the Advance HCI-H goes through a complete self test and initialize procedure that is similar to the procedure, initiated on power up. There are certain differences however. First, the Advance generates its Advance Response Message to the HOST. Then the Advance performs the desired full normal power up restart.

Data Address Structure

Function Codes X'01' through X'06' plus X'66' are intended to enable the HOST to communicate useful information to and from the Advance Analyzer System. Such information is normally such things as component concentration values obtained by the Advance through chromatographic analysis and operational status of the Advance analyzers.

In actual physical implementation of the Advance System, there are typically multiple Advance Analyzers present. Each of these analyzers is connected via communication cables and they share information through this Siemens Applied Automation, Inc. Advance Data Hiway. The HCI-H as noted above is a printed circuit board which is connected to the Advance Data Hiway and so has access to information measured by the Analyzers themselves.
In the communications protocol being described in this manual - which the HCI-H implements - all desired analyzer data is gathered and stored in memory within the HCI-H. It resides in that memory and is available for immediate transmission if it is requested by the HOST. The memory structure of the HCI-H and the location of data from the various analyzers in that memory is precisely defined so as to be most useful to gateway devices used by the HOST computing equipment for which this communication protocol is intended.

The memory structure and the arrangement of analyzer data in that structure, is the subject of this and the next three sections entitled "Data Layout in Memory", "Meaning of Analyzer Data" and "Data Timing Considerations".

Notation and Conventions

All memory addresses will be referred to in decimal notation. Memory is segmented into portions which are accessible via various Function Codes that are used in HOST

Transmissions. Memory in each segment will range in address from 00001 to 19999 (Digital Coil), and 30001 to 49999 (Analog Register).

There is - as noted above - a hardware strap option on the board which omits the number of streams power analyzer and the number of components per stream to a nominal 8 or a nominal 9. As will be detailed below, this strap effectively limits the memory address structure to the range of 00001 to 18888 and 30001 to 48888.

(Note again, the memory arrangement is chosen to be compatible with standard software available in HOST equipment for which this protocol is intended.)

Memory in a segment is accessible only when in combination with specified function codes. Some of the memory areas are intended to contain digital (status and control) data. Some of them are intended to contain analog (measurement) data. Additionally, some of the segments can be written to by the HOST using Function Codes x'05, x'06 and x'66, while some segments are protected from modification by the HOST.

Here is a table of the relationship between memory segments and Function Codes.

CODE MEANING MEMORY ACCESSED (Hex) (HOST relative) (xxxx range 0 to 9999)

01 05	Read Digital Write Digital	0xxxx	Digital OUTPUT Control Streams 0-9
02	Read Digital	1xxxx	Digital INPUT Status Streams 0-9
03 06	Read Analog Write Analog	4xxxx	Analog OUTPUT Value Streams 0-9

04 Read Analog 3xxxx Analog INPUT Value 66 Write Analog Stream 1, Components 0-9

The range of Memory Addresses that are valid as data items in a HOST Transmission are indicated above. As described above in the section entitled "Advance Exception Response", if a memory address is outside of a valid range, it will generate an error message from the Advance HCI-A.

Note on Size of Memory Locations

As may be apparent from the type of data contained in the described memory addresses, the locations do not necessarily coincide with physical implementation in HCI-H memory.

A digital memory location contains exactly one bit of information. An analog memory location contains one item of analog information which is exactly 16 bits in size.

Reference documentation mentioned at the start of this section refers to these locations as "coils" and "registers" which is a reference to the relay heritage of the HOST equipment software which is compatible with this protocol.

Data Layout in Memory

This section describes the actual assignment of analyzer data to the memory addresses explained above. The following section will deal with the meaning of the analyzer data assigned.

Digital Memory Information Digital Memory Information (Continued)

ADDRESS	MEANING
	System Information (Stream 0)
00001	Not used.
00002	1 = power up procedure just completed. Set by HCI-H following HCI-H power up process. Reset (if desired) by HOST. An attempt to set this location by HOST is ignored and an exception response is made.
00003 thru 00008	Not used.
00009	HOST Alive. Set by HOST, reset by HCI-H. An attempt to reset by HOST is allowed but is not intended. This bit is directly associated with an indicator light on the front of the HCIH.
00010	System Data Base Change. Set by HCI-H, reset by HOST. An attempt by HOST to set is ignored and an exception response is made.
00011	Suspend Maximum Change Test. Set and reset by HOST; reset on power up. This bit performs a function similar to other bits described below but is not logically attached to them by the HCI-H.

ADDRESS

00012 thru 00050

0s001 thru 0s050

0s051 thru 0s100

0s101 thru 0s150

MEANING Not used.

Stream Control and Status Information for Analyzers 1 through 50

In the following memory segments, the last three digits relate to analyzer numbers 1 through 50. The lowest address in the range corresponds to analyzer number 1 and the upper number corresponds to analyzer 50.

Also "s" refers to stream number and has values 0 through 9. Stream "0" is taken to mean "applies to all streams" and is implemented in various manners as described in each section below.

0 = Run Enables or Disables the 1 = skip stream analysis. Specified Stream

Set and reset by HOST and HCI-H.

Note: There is not a Stream 0 section with this definition. See System information descriptions above.

0 = normal cycle; 1 = Run only this stream and others on same analyzer.	Sets C(5) = 0 Sets C(5) = The STRM Selected
Set and reset by HOST. However, HCI-H will force a reset on all streams for one analyzer if HOST sets or resets a memory segment 01667 through 01716 as described below.	The Run-Hold Feature overrides the address but does not clear them.

Stream 0 section is not used and is forced 0.
If HOST attempts a set or reset, an exception response is made.

Stream Control and Status Information for Analyzers 1 through 50

0 = this stream is not currently being analyzed;
1 = this stream is currently being analyzed.

Set and reset by HCI-H.
An attempt to change these by HOST is ignored by HCI-H and an exception response is made. HCI-H maintains these bits as mutually exclusive; only 1 may be set at a time.

Digital Memory Information (Continued) Digital Memory Information (Continued)

ADDRESS	MEANING
	Stream 0 section is not used. Forced 0.
0s151 thru 0s200	0 = normal operation; 1 = EUHI has changed for some component. Set by HCI-H, reset by HOST. A set by HOST is ignored by HCI-H and an exception response is made. The bit is set if the HCI-H makes any change to the corresponding analyzer data in locations 4sc51 through 5sc00.
	The stream 1 portion of this section is redundant to addresses 02667 through 02716. The HCI-H forces these two locations to match. If either location is reset by the HOST, the HCI-H also resets the other location.
	Stream 0 section is maintained by HCI-H as a logic OR function of individual streams. If Stream 0 is ever reset by HOST, HCI-H forces resets on all individual streams.
0s201 thru 0s250	0 = normal operation; 1 = something other than EUHI has change din this stream. Set by HCI-H, reset by HOST. A set by HOST is ignored by HCI-H and an exception response is made.
	The stream 1 portion of this section is redundant to addresses 03667 through 03716. The HCI-H forces these two locations to match. If either location is reset by the HOST, the HCI-H also resets the other location.
	Stream 0 section is maintained by HCI-H as a logic OR function of individual streams. If Stream 0 is ever rest by HOST, HCI-H forces reset on all individual streams.

Stream Control and Status Information for Analyzers 1 through 50

Not used.

0s251 thru 0s300

Not used.

0s301 thru 0s350

ADDRESS

0s351 thru 0s400

0s401 thru 0s450

0s451 thru 0s666

00667 thru 00920

0s921 thru 0s999

MEANING

0 = normal operation;
1 = run calibration.

Set by HOST, reset by HCI-H after completion of calibration.
An attempt by HOST to reset is ignored by HCI-H and an exception response is made.

The stream 1 portion of this section is redundant to addresses 06667 through 06716.
The HCI-H forces these two locations to match.
If either location is set by the HOST, the HCI-H also sets the other location.
When calibration is complete, the HCI-H resets both locations.

If Stream 0 section is set by HOST, HCI-H forces a set on all individual streams.
When all streams are eventually reset by HCI-H, it also resets the stream 0 section.

0 = perform maximum change test;
1 = suspend maximum change test.

Set and reset by HOST.

The stream 1 portion of this section is redundant to addresses 07667 through 07716.
The HCI-H forces these two locations to match.
If either location is set or reset by the HOST, the HCI-H also sets or resets the other location.

Whenever stream 0 section is changed by HOST, HCI-H forces all individual streams to match.

Not used. (Streams 0-9)

Stream Control and Status Information for Analyzers 1 through 50

Not used. (Stream 0)

Not used. (Stream 0-9)

Digital Memory Information (Continued)

ADDRESS	MEANING
	Analyzer Status and Control Information for Analyzers 1 through 254
	In the following sections, the last three digits of the address relate to analyzer number. The lowest address corresponds too Analyzer 1 and the upper address corresponds to Analyzer 254.
01667 thru 01920	
	0 = normal run; Run 1 = force standby. Hold Set and reset by HOST.
02667 thru 02920	0 = normal operation; 1 = EUHI has changed for some component. Set by HCI-H, reset by HOST. A set by HOST is ignored by HCI-H and an exception response is made. The bit is set if the HCI-H makes any change to the corresponding analyzer data in locations 3c255 through 3c508.
	For analyzers 1 through 50, this is redundant to Stream 1 section of 0s151 through 0s200. The HCI-H forces these two locations to match. If either location is reset by the HOST, the HCI-H also resets the other location.
	Analyzer Status and Control Information for Analyzers 1 through 254
03667 thru 03920	0 = normal operation; 1 = Something other than EUHI has changed in this analyzer. Set by HCI-H, reset by HOST. A set by HOST is ignored by HCI-H and an exception response is made.
	For analyzers 1 through 50, this is redundant to Stream 1 section of 0s201 through 0s250. The HCI-H forces these two locations to match. If either location is reset by the HOST, the HCI-H also resets the other location.
	Not used.
04667 thru 04920	
	Not used.
05667 thru 05920	

Digital Memory Information (Continued)

ADDRESS

06667 thru 06920

07667 thru 07920

08667 thru 08920

09667 thru 09920

MEANING

0 = Normal Operation 1 = Run Calibration	The ANLZ and its sample system must be setup for auto-cal for this feature to operate.

Set by HOST.

Reset by HCI-H after completion of calibration.
A reset by HOST is ignored by HCI-H and an exception response is made.

For analyzers 1 through 50, this is redundant to Stream 1 section of 0s351 through 0s400. The HCI-H forces these two locations to match. If either location is set by the HOST, the HCI-H also sets the other location. When calibration is complete, the HCI-H resets both locations.

Analyzer Status and Control Information for Analyzers 1 through 254

0 = perform maximum change test;
1 = suspend maximum change test.

Set and reset by HOST.

For analyzers 1 through 50, this is redundant to Stream 1 section of 0s401 through 0s450. The HCI-H forces these two locations to match. If either location is set or reset by the HOST, the HCI-H also sets or resets the other location.

0 = Operate in normal concentration scan time mode
1 = Operate in "slow concentration scan time" mode.

Set and reset by HOST.

Normal concentration scan time is 1 second.
Slow concentration scan time is as established in memory location 40001, described below.

Not used.

Analyzer "Read Me" Status Bits (HOST cannot write to these bits)

In the following sections, "s" relates to stream number and can have values 1 through 9. The last three digits of the address relate to analyzer number and can have values 1 through 254.

Digital Memory Information (Continued) Digital Memory Information (Continued)

ADDRESS	MEANING
10001 thru 10999	Not used. (Stream 0)
	Analyzer "Read Me" Status Bits
1s001 thru 1s050	0 = Data is old; 1 = New data, HOST should come read. Analyzer 1 through 50 "Read Me" bits with one location in each analyzer for each of streams 1 through 9. Set and reset by HCI-H. The bit is set by HCI-H when a new value is written in corresponding ana lyzer locations in memory addresses 3c001 through 3c050 and 4sc01 through 4sc50 as described below. There are certain timing constraints, however, which are described in section 6 of "Meaning of Analyzer Data".
11051 thru 11254	0 = Data is old; 1 = New data, HOST should come read. Set and reset by HCI-H. The bit is set by HCI-H when a new value is written in corresponding ana lyzer locations in memory addresses 3c051 through 3c254 as described below.

There are certain timing constraints, however, which are described in section 6 of "Meaning of Analyzer Data".

1s051 thru 1s254	s = 2 through 9. Not used. (Streams 2-9)
1s255 thru 1s999	s = 0 through 9. Not used. (Streams 0-9)

Analyzer Operational Status and Component Measurement Location

Stream 1

The last three digits of the address refer to Analyzer Number 1 through 254 with the lower address corresponding to Analyzer 1 and the upper address corresponding to Analyzer 254.

30001 thru 30254	Analyzer Operational Status Code RSLT 10 Written by HCI-H. An attempt to write by HOST will be ignored and an exception response made.

ADDRESS	MEANING
	Analyzer Operational Status and Component Measurement Location
30255 thru 30508	Analyzer cycle time. RSLT 9 Total cycle if multiple streams as on analyzers 1 through 50.) Written by HCI-H. An attempt to write by HOST will be ignored and an exception response made.
30509 thru 30558	Stream number if analyzer 1 through 50 is running on a dedicated stream. RSLT 5 This value is written by the HCI-H and will correspond to information in digital memory locations 0s051 through 0s150. An attempt to write by HOST will be ignored and an exception response made.
30559 thru 30999	Not used.

Stream 1

In the following sections "c" refers to component number and can have values 1 through 9.

3c001 thru 3c254	Component Concentration expressed as a percentage of EUHI.	RSLT 14,18,22, 26,30,34, 38,42,46

(See description of data below in another section.) Written by HCI-H. An attempt to write by HOST will be ignored and an exception response made. If a change is made by HCI-H, a bit is set for the corresponding analyzer in memory locations 1s001 through 1s050 and 11051 through 11254. There are certain timing constraints, however, which are described in section 6 of "Meaning of Analyzer Data".

For analyzers 1 through 50, this applies only to stream 1 and is maintained by the HCI-H to be equal to the value in 4sc01 through 4sc50. When the value is changed in either location by the HCI-H, it also changes the other location to the same value.

Digital Memory Information (Continued)

ADDRESS	MEANING Analyzer Operational Status and Component Measurement Location	
3c255 thru 3c508	Component EUHI value.	RSLT 15,19,20, 27,31,35, 39,45,47

Written by HOST or HCI-H.

If written by HOST, HCI-H notes the change and makes appropriate changes in actual Advance analyzers. If written by HCI-H, it also sets the corresponding analyzer bit in memory locations 0s151 through 0s200 and 02667 through 02920.

For analyzers 1 through 50, this applies only to stream 1 and is maintained by the HCI-H to be equal to the value in 4sc51 through 4sc00. If the value is changed by the HOST or the HCI-H itself in either location, the HCI-H changes the other location to the same value.

3c509 c = 1 through 9. Not used. (Components 1 - 9) thru 3c999

System Data (Stream 0)

40001 HOST Slow Concentration Scanning Rate for component concentrations.

This location is written only by HOST.
This value affects the way in which the HCI-H handles the "Read Me" data bits.
This value is initialized by the HCI-H to 15 seconds.
It is referenced by a flag set in memory location 08667 through 08920 as described above.

40002 Not used. thru 40032

ADDRESS	MEANING
	Analyzer Operational Status and Component Measurement Location
40033 thru 40039	System Real Time Clock, set by HOST and used by HCI-H to synchronized all analyzer clocks. This information is written by HOST, updated by HCI-H.
40033	Seconds (in milliseconds)
40034	Minutes (00-59)
40035	Hours (00-23)
40036	Day of Month (01-31)
40037	Months (01-12)
40038	Years (00-99)
40039	Day of Week (01-07)
40040 thru 40050	Not used.
40051 thru 40150	Information required for 'Roll-Over Table'. This is further described below.
	Written by HCI-H. An attempt to write by HOST will be ignored and an exception response made.
40151 thru 40999	Not used.
	Additional Composition Information for Analyzers 1 through 50
	In the following memory addresses, "s" refers to stream number has values 1 through 9, and "c" refers to component number and has values 1 through 9.
4sc01 thru 4sc50	Component concentrations expressed as a percentage of EUHI. RSLT 14,18,22, 26,30,34, 38,42,46
	Written by HCI-H. An attempt to write by HOST will be ignored and an exception response made. If a change is made by HCI-H, a bit is set for the corresponding ana lyzer in memory locations 1s001 through 1s050. There are certain timing constraints however, which are described in section 6 of "Meaning of Ana lyzer Data".

Digital Memory Information (Continued)

ADDRESS	MEANING

Note: the values in these locations are forced by the HCI-H to equal the values for the

corresponding analyzers, stream 1 only, that is stored in locations 3c001 through 3c050 as described above. When the value is changed in either location by the HCI-H it also changes the other location to the same

value.

4sc51 thru 4sc99,00	Component EUHI values.	RSLT 15,19,23, 27,31,35, 39,43,47

Written by HOST or HCI-H.

If written by HOST, HCI-H notes the change and makes appropriate changes in actual Advance analyzers. If written by HCI-H, it also sets the corresponding analyzer bit in memory locations (0s151 through 0s200 and 02667 through 02920.

Note: the values in these locations are forced by the HCI-H to equal the values for the corresponding analyzers, stream 1 only, that is stored in locations 2c255 through 3c304 as described above. If the value is changed in either location by the HOST or by the HCI-H itself, the HCI-H changes the other location to the same value.

General Notes on Data Handling

There are certain points to be noted on the methods used in the Advance System implementation of this protocol that may be of concern to HOST programmers regarding the way in which data messages from the HOST are processed by the HCI-H and various Advance analyzers. These points are stated here. This section is referenced several times in a subsequent section "Meaning of Analyzer Data."

1. Data which is to be sourced by the Advance Analyzer System to the HOST is generally measured physically by individual Advance Analyzers which are distributed on the Advance Data Hiway. Therefore, when the HOST interrogates the HCI-H for data, it is obtaining data which was originally measured by other devices.

In order to avoid communication delays which may be unacceptable to the HOST, all data which is to
be available to the HOST is transmitted by Advance Analyzers to the HCI-H where it is retained in a lo
cal buffer memory. This means, that when the HOST "reads" data from the Advance system, it is
reading an image of that data maintained by the HCI-H. Therefore, there are no significant delays in the
ability of the HCI-H to respond to HOST inquiries.

2. Data which is sourced by the HOST to Advance Analyzers - such as commands to select analysis procedures, do calibration, change component ranges, and run or skip specified streams - are handled a little differently. Generally, such information is accepted by the HCI-H but immediately passed on to affected analyzers for that analyzer to use. Because it is generally not desirable for the HOST to have to wait for a response from the HCI-H while this communication is in progress (that is, between HCI-H and affected analyzers) the HCI-H

buffers the received information in local memory and immediately responds to the HOST.

However, if subsequently, the HCI-H is unable to successfully transmit the required data on to the affected analyzer, the HCI-H marks the flag which indicates to the HOST that the data base has been changed. It also marks current data as bad (concentration data = 65,535).

2 Most non-digital information (component concentrations, EUHI, and status levels) is transmitted to the HOST as a numerical value which ranges between 0 and some upper limit. The fact that all memory registers are at most 2 bytes in size limits the upper limit to 65,535. However, in many HOST applications it is desirable to have a different upper numerical limit. Typical values used for this are 999, 4,095, 10,000 and 65,534 (2**16-2). Each analyzer in the Advance System has one entry which is made through a user service panel which sets this value. The HCI-H observes this value and guarantees that all transmissions to the HOST are scaled appropriately. The significance of this value is further discussed below in the section entitled "Meaning of Analyzer Data".

3 Because of the HCI-H and the Advance Analyzers are physically separate devices, it is possible for one or the other to loose power or be manually reset and so be "out of sync" temporarily with the other.

When this occurs, the HCI-H checks for changes that may have been made in the analyzer during that time. If any changes have been made, the HCI-H sets flags in the appropriate memory locations to indicate Data Base change. In addition, it marks current data as bad.

Items of data which are checked for possible change are as follows.

a. EUHI - Engineering Unit High; one value for each reported component.
b. Numerical value used for upper limit of fractions; one value per analyzer.
c. Number of reporting streams per analyzer for each of the first 50 analyzers.
d. Number of reporting components per stream for each stream of the first 50 analyzers.
e. The RUN/SKIP status of any given stream or the fact that a different stream is selected for dedicated run on the first 50 analyzers.
f. Component maximum change limit; one per component.
g. Component minimum expected change and number of analysis cycles to achieve change; one of each values per component.

NOTE

Items a. and b. result in the EUHI Change flag bit being set. All other items result in the Data Base Change Other Than EUHI flag bit being set.

Also note items c., d., and e. apply only to the first 50 analyzers because the others are by
definition not allowed more than 1 stream or 9 components per stream.

If any stream is disabled, the component concentration for that stream only will be forced to take on a "bad" value.

Meaning of Analyzer Data

This section provides supplemental information about the data contained in the various

memory addresses as described in the previous section. In addition, a cross-reference table to the memory address section is provided.

1. EUHI - Engineering Units, High Concentration

    RSLT 15, 19, 23, 27, 31, 35, 39, 43, 47,.....

    This value provides component range information to the HOST. As will be explained in the next item of this section, component concentration is expressed as a fraction of range and is capable of showing an error condition. The range over which a component concentration may exist is 0 through EUHI. EUHI may be determined by the applications engineer of either the Advance Analyzer or the HOST.

    Numerically the value is expressed to the HOST as a 16-bit floating point number.

    In implementation in the Advance system, the EUHI value is entered in Analyzer memory in standard engineering units representation as desired by the engineer at the Advance user service panel. The HCI-H receives this Advance representation from the analyzer and converts it to the special floating point representation required by this protocol internally. This assures that the scaling information used to express component concentration has the correct number of significant bits. (Note, EUHI is the only value in this protocol which carries this floating point representation. All other values are straight fixed point binary representations.)

    Whatever value is chosen for EUHI, it must be understood to be the same in both the HOST and the Advance analyzer. Therefore, the value may be written from HOST. If this is done, the HCI-H notes the change and forces the Advance analyzer to make a corresponding change.

    Alternatively, the value may be changed at any time by analyzer maintenance personnel. If this is done, the HCI-H observes the change and sets the "EUHI Change Bit" in the appropriate memory address. The HOST is expected to note this change and inquire for correct information.

2. Component Concentration

    RSLT 14, 18, 22, 26, 30, 34, 38, 42, 46.....

    This is the information which expresses measurement results as obtained by the analyzer. It is available to the HOST as a number which is to be interpreted as a fraction of the range from 0 to EUHI. (Note in this protocol, the Engineering Units, Low Concentration point defaults to 0.).

    The range upper limit is EUHI as described in the previous item. The fraction which represents the concentration itself is also determined by agreement between the Analyzer and the HOST engineers. The upper limits of this fraction may have any value from 0 to 65534 (2**16-2). It is normally chosen to be one of four standard values; namely, 999; 4,095; 9,999; or 65,534. Once agreed to, it is entered by the analyzer engineer through the Advance user service panel. If, thereafter, it is changed by the analyzer technician, it

constitutes a change in "EUHI" and the Advance HCI-H takes action as described above. If the Analyzer Technician enters any number greater than 65,534, the HCI-H assume 65,534.

The component concentration value is transmitted from the Advance Analyzer to the HCI-H after converting it to the percentage of range determined by EUHI and the agreed upon fraction upper value.

The conversion performed is: Value for HOST = (component concentration * Fraction) / EUHI.

An example will be used to demonstrate this expression.

Assume the upper end of normal component range (EUHI) is 50% and the HOST operates with the desired fraction expressed as 0 to 9,999. Then if the actual component concentration measured is 35%, the value calculated by the Analyzer to be presented to the HCI-H in the concentration memory location is:

Value = (35 * 9999) / 50 = 6999.

If there is an error in analyzer operation, the HCI-H forces the component concentration to take on a "bad" value. A "bad" value is always the number 65535. Note, this is why if EUHI is determined by the applications engineer to be 65535 or higher, the HCI-H automatically decrements that number by one unit.

"Bad" data is determined by any one of the following conditions:

*a. EUHI has been changed since the last analysis.

b. The Advance analyzer had a "Fault" class alarm on the current analysis.

c. The actual component contraction was higher than EUHI.

d. The component concentration changed by an amount that was greater than a user specified maximum change limit. This change occurred between the current analysis cycle and the previous cycle. The change limit is entered through the user service panel.

e. The component concentration has not changed enough in the last several cycles. This implies the Analyzer has bad hardware and is not performing a real analysis. The desired minimum change limit and the number of cycles that must pass without minimum change occurring before alarm are both user specified and entered at the Advance analyzer user service panel.

*f. The Advance analyzer has ceased communication with the HCI-H. The HCI-H will make this determination at least once per minute.

*= Determination made by HCI-H; all other determinations made by the ANLZ prior to sending TOR data to HCI-H.

NOTE

With regard to the maximum change limit check. The HOST can command this check to

be terminated and later command it to be restarted. This facility is provided to accommodate changes that occur in process startup. In addition, all bad data checks can be overridden by the analyzer technician if desired.

3. Analyzer cycle time. RSLT 9

This is the predicted real time in seconds before the component concentrations provided will be updated again. The Advance analyzer transmits this time to the HCI-H based on its current cycle lengths, the number of streams it has to run, and the current skip/run status of those streams.

NOTE

This information is provided for reference only to the HOST. It is subject to wide variations
if the analyzer stream sequencing is being changed by HOST or by analyzer personnel.

As with component concentration, the cycle time is expressed as a fraction of a range. The actual upper range limit ("EUHI" equivalent for cycle time) always is forced to 65,534 seconds. The upper fraction value is entered by the Analyzer technician and transmitted to the HCI-H via the Advance Data Hi-way. This value - as with the component concentration fraction - is commonly 999; 4,095; 9,999; or 65,534 although any fractional limit up to 65,534 is permitted. The Analyzer cycle time is presented to the HOST as:

Value for HOST = (time in seconds * Fraction) / 10,000.

NOTE

This protocol assumes no real analyzer cycle exceed 10,000 seconds in length. Any longer
time that actually occurs is treated as 10,000 seconds.

4. Analyzer Status Value. RSLT 10

This is a numerical value that is intended to provide the HOST with a scaled value which represents "how well the analyzer is operating". The value and scaling technique are chosen to permit visual scaling in some HOST Hardware of the value - the larger the value, the better the analyzer. A "full scale" value is a perfect analyzer.

The numerical value is expressed on a range from 0 to 999. The equivalent "EUHI" for this value is forced at 999. The fractional upper limit is entered by Analyzer technicians using the Advance user service panel and is transmitted to the HCI-H for scaling for proper presentation to the HOST. As described previously, this fractional upper limit may be any number from to 65,534 but is typically 999; 4,095; 9,9999; or 65,534.
The analyzer maintains its status value according to the following table:

STATUS	MEANING
1000	Perfect, normal operation.

9SSS Advance WARN alarm; analyzer running on stream SS.
800 Analyzer in Manual Mode. Is subject to some change.
7SS Analyzer performing automatic calibration on stream SS.
6SS Analyzer in Manual Mode, performing calibration on stream SS.
5SS Maximum change test exceeded.

* 4SS Some change has been made to the Data Base; analyzer running stream SS.

3SS Excessive rate of change test failed.
2SS Minimum rate of change test failed.
100 Analyzer FAULT alarm present.
50 Analyzer temporarily out of service.

* 0 Analyzer not responding to HCI-H.

*=Status values determined by the HCI-H.

NOTE

This entire table of information is not maintained in Advance analyzers per say in a manner visible to the technician via the user service panel. This value is assembled by the analyzer prior to sending the TOR data to the HCI-H.

The resulting value is scaled against the upper fractional limit being used by the HOST in the same manner that the component concentrations and cycle times are scaled. The formula used is:

Value for HOST = ANLZ STATUS VALUE = * 999/Frac. Full Scale

NOTE

This value must be rounded to recover the right status.

5. Dedicated Stream Number. RSLT 5

Since analyzers 1 through 50 can have more than one stream, this protocol provides a method of sending an analog representation of stream number if one of the analyzers is running on a dedicated stream. Typically, this information is usable to HOST engineers for display purposes.

As with previous analog information, the stream number is passed as a value expressed against fractional upper limit. The formula exercised by the Analyzer before transmission is:

Value for HOST = (analyzer stream number * Fraction) / 100.

6. Read Me Data Flags

These are status flags set in the memory locations described above. They are used by the

HCI-H to indicate to the HOST that the information available for an analyzer is new. It is recognized that HOST Hardware has a finite time requirement to obtain all information from the HCI-H. This might make it possible therefore for there to be a partial update of information presented to the HOST if the HCI-H were in to process of updating memory concurrent with a HOST read from memory.
To prevent this occurrence, the Read Me flag is set by the HCI-H only after memory has been fully updated. It is then reset by the HOST at its convenience or by the HCI-H some amount of time before data is to be updated again.

Then the HCI-H stores all the new data in its memory while performing necessary status checks needed to set various flag bits. Then the HCI-H waits the Concentration Scan Time interval and sets the Read Me bit.

7. Slow Concentration Scan Time

The Concentration Scan Time discussed in the previous section defaults to one second. If the HOST needs a different time, it may load that time in the appropriate memory location. The value loaded is a direct binary count of seconds desired. Then the HOST may set the flag bit in the appropriate memory location that instructs the HCI-H to use the Slow Concentration Scan Time.

The default time is 16 secs.

8. Analyzer Procedure Selection

The Advance Analyzer procedure number does not exist as a value, i.e., the procedure cannot be selected. The procedure is defined to be "1".

Please reference also the earlier section, "General Notes on Data Handling."

9. Calibration Method. Select Calibration Flag.

The HOST causes the HCI-H to initiate calibration by setting a flag in the appropriate memory location. When this occurs, the HCI-H sends a message on to the correct analyzer on the Advance Data Hiway which initiates automatic calibration. (Reference the earlier section, "General Notes on Data Handling.")

2 Suspend Maximum Change Test. Suspend Maximum Change Test on System.

As has been described, the Advance analyzers normally test each analysis in comparison to the previous analysis to determine if there has been excessive change. If such occurs, the component values presented to the HOST are marked "bad"; that is they are forced into the value 65,535. It is noted however that in process upset conditions, the process operator may expect significant changes and will not want an analysis that shows this called "bad". Therefore, this protocol provides for a method of suspending the maximum change test and preventing. Advance analyzers and the HCI-H from marking component values bad. This suspension of test may be done on a:

a) per stream basis for Analyzers 1 through 50,
b) per analyzer basis for Analyzers 51 through 254, or
c) for the whole system at one time.

It should be noted that there is never a deviation failure upon completion of calibration. That is, on the first analysis after completion of calibration, the Maximum Change Test is automatically suspended.

Rollover Table

In normal configuration, only analyzers 1-50 (of the 254 supported by this protocol) can have more than one stream. Normally, the limit on the number of streams allowed on those 50 analyzers is 9. In addition, there is normally a limit of 9 components that can be reported for any stream in the system.

This limit of 9 may - by hardware strapping - be further limited to 8. This further limitation is provided to be compatible with some HOST software in which the addressable memory is further restricted.

Since there are often situations in which some analyzers need to have more than 9 streams or there are in fact more than 9 components per stream, this protocol provides for a manner that this can occur. Such an analyzer must be among the first 49. Then, that analyzer is allowed to "roll over" into the next analyzers allocated to two streams. Note, that analyzer 10 did not use any memory allocated to analyzer 11 so real analyzer 11 may still exist.

NOTE

There is no provision made in the HCI-H for preventing Analyzer 49 rolling into Analyzers 50 and 51 memory space. Unpredictable results should be expected if this occurs.

This protocol provides for a convenient way for this roll over to be handled with minimum pain for the user. This will be described below. But first some examples will be beneficial.

Examples:

If analyzer 2 has 10 streams and 8 components per stream, its 10th stream "rolls into" the memory space allocated for analyzer 3. Then, in that system, there may not be an actual analyzer 3. The next legal analyzer is number 4.

Also, if analyzer 10 has 4 streams with 12 components each, each stream "rolls into" memory allocated for the subsequent stream. That is, stream 1 "rolls into" stream 2 memory which displaces stream 2 up into stream 3 memory. Then stream 2 rolls further into stream 4 memory displacing streams 3 and 4 into stream 6 and 8 memory respectively. That is, each stream uses memory allocated to two streams. Note, that analyzer 10 did not use any memory allocated to analyzer 11 so real analyzer 11 may still exist.

Also if analyzer 15 has 12 streams with 15 components each then each stream rolls into the next stream's allocated memory. Plus, higher numbered streams actually roll into the next analyzer's allocated memory. In this case, each of the 12 streams requires 2 stream's worth of memory for a total of 24 stream's worth of memory consumed. Since one analyzer

is defined normally to use the memory of 9 streams, this analyzer used 3 real analyzers worth of memory, totally. so real analyzers 16 and 17 are no longer legal in the system.

The HCI-H automatically keeps track of which analyzer is in what memory so the user doesn't have to. If an analyzer is inadvertently assigned into an analyzer number which requires memory already allocated to a previous analyzer, an alarm is generated which allows that analyzer to be renumbered through its user service panel. The HCI-H keeps track of this information in a section of memory which is available tot he HOST. Therefore, HOST software can determine what real analyzer is in what memory.

NOTE

The memory to track the streams/components per analyzer is initialized at, power up, to a "zero" condition. This is a bias value of 64, in order to allow negative values to be represented (63 = -1, 62 = -2, etc.)

The memory locations used to track the analyzer/memory used function are locations 40051 through 40150. This map as follows:

Analyzer	Location	Streams per Components Per Analyzer Stream
1	40051	64 + 0
1	40101	64 + 0
2	40052	64 + 0
2	40102	64 + 0
3	40053	64 + 0
3	40103	64 + 0
4	40054	64 + 0
4	40104	64 + 0
5	40055	64 + 0
5	40105	64 + 0
:		
:		
50	40100	64 + 0
50	40150	64 + 0

All locations shown above default to 0 (64) when the HCI-H is powered up. The HCI-H adjusts the table contents as each of the first 50 logical Analyzers transmit their TOR data.

If an analyzer has more than 9 streams, or, if its streams have enough more than 9 components that it requires space allocated to the next analyzer, its values are set into the table as required and the next analyzer is marked by negative flag numbers as needed. A flag number consists of the value -1, -2, -3, etc. with each subsequent analyzer whose memory has been taken having the more negative number. Each flag sequence begins with the -1 value, and extends as dictated by the present Analyzers space requirements.

NOTE

The Rollover table is developed in a chronological manner, i.e., in the order of the ANLZs TOR requests.

A table reflecting the examples given above is presented here:

Analyzer	Streams per Analyzer	Components per Stream
1	64 + 9	64 + 9
2	64 + 10	64 + 8
3	64 - 1	64 + 0
4	64 + 9	64 + 9
5	64 + 9	64 + 9
6	64 + 9	64 + 9
7	64 + 9	64 + 9
8	64 + 9	64 + 9
9	64 + 9	64 + 9
10	64 + 4	64 + 12
11	64 + 9	64 + 9
12	64 + 9	64 + 9
13	64 + 9	64 + 9
14	64 + 9	64 + 9
15	64 + 12	64 + 13
16	64 - 1	64 + 0
17	64 - 2	64 + 0
18	64 + 9	64 + 0
19	64 + 9	64 + 9
20	64 + 9	64 + 9
:		
:		
50	64 + 9	64 + 9

Advance Implementation

As has been discussed earlier, Advance consists of a system of several independent analyzers connected via a communication data hiway. The HCI-H is itself independent from

each analyzer. This section details which functions are performed in what units in the implementation of this protocol.

There are three objectives that are met in this allocation of functions.

1 Maximize flexibility for the Analyzer Engineer.
2 Maximize ease of use and maintenance understanding for the analyzer technician.
3 Meet protocol requirements even in the event of independent actions by the HCI-H and the various analyzers such as separate maintenance or separate power cycles.

General Notes

HCI-H to determine for itself the rollover table requirements; i.e., analyzers, streams, and components configuration.

HCI-H to be able to activate alarm event in analyzer if rollover table requirements have not been accommodated.

HCI-H to be able to select, run, and skip streams.
Analyzer probably to run its own deviation tests, i.e., too much change or not enough change after a certain number of cycles.

HCI-H to be able to tell the analyzer not to run deviation tests.

Analyzer probably to mark its own data base (i.e. set value to 65,535) or whatever it takes to force that in the HCI-H. Some customers are going to want even "bad" data to come through with its value showing. This probably can be done by sending redundant data as a different "component" which is not marked bad.

HCI-H to be able to calculate its own "Analyzer Status" value from available information. Don't think it's very desirable to have this done in the analyzer proper.

Desire required programming in Advance required to accommodate this protocol to be "additional to" any other more normal programming required merely to make the analyzer run, i.e. Would wish to take the standard application table set - which doesn't do this protocol - and add a "standard collection" of events, results, factors, etc. necessary to implement this protocol.

Analyzer probably to inform HCI-H of estimated time to next analysis.

HCI-H to figure out for itself when to set and reset Read Me bits.

HCI-H to be able to figure out if an analyzer went away and then to mark its data bad for the HOST. When the analyzer comes back, HCI-H to make some kind of determination if there is any data base change.

CRC Calculation Method, Example

Sample Program:

Note:

CRCTMP	is a 16 bit integer
CHAR(I)	is one of a string of 8 bit-characters transmitted CHAR (1) through CHAR(n). CHAR(n+1) and CHAR(n+2), the CRC chars, follow.

```
CRCTMP:=HEX(FFFF)
FOR I = 1 to N DO; CRCTMP:=CRCTMP .XOR. CHAR(I) FOR J = 1 to 8 DO;
    CRCTMP:=CRCTMP/2: /*MSB gets zero, flag gets LSB*/ IF FLAG = 1
    THEN CRCTMP:=CRCTMP .XOR. HEX(A001):
            END: END: CHAR(N=1):CRCTMP (Right byte) CHAR(N+2):=CRCTMP (Left byte)
```

Example: Develop CRC for 2 bytes of input (X'02' and X'07').

Initialize CRCTMP 1111 1111 1111 1111 FFFF XOR 1st char (x'02') 0000 0010 02

1111		1111	1111	1101	FFFD
Shift 1	0111	1111	1111	1110	7FFE
Flag is 1, XOR Polynomial	1010	0000	0000	0001	A001
	1101	1111	1111	1111	DFFF
Shift 2	0110	1111	1111	1111	6FFF
Flag is 1, XOR Polynomial	1010	0000	0000	0001	A001
	1100	1111	1111	1110	CFFE
Shift 3	0110	0111	1111	1111	67FF
Flag is 0, shift 4	0011	0011	1111	1111	33FF
Flag is 1,	1010	0000	0000	0001	A001
	1001	0011	1111	1110	93FE
Shift 5	0100	1001	1111	1111	49FF
Flag is 0, Shift 6	0010	0100	1111	1111	24FF
Flag is 1,	1010	0000	0000	0001	A001
	1000	0100	1111	1110	84FE
Shift 7	0100	0010	0111	1111	427F
Flag is 0, Shift 8	0010	0001	0011	1111	213F
Flag is 1,	1010	0000	0000	0001	A001
	1000	0001	0011	1110	813E
XOR 2nd char (X'07')			0000	0111	07
	1000	0001	0011	1001	8139
Shift 1	0100	0000	1001	1100	409C
Flag is 1,	1010	0000	0000	0001	A001
	1110	0000	1001	1101	E09D
Shift 2	0111	0000	0100	1110	704E
Flag is 1,	1010	0000	0000	0001	A001
	1101	0000	0100	1111	D04F
Shift 3	0110	1000	0010	0111	6827

Flag is 1,	1010	0000	0000	0001	A001
	1100	1000	0010	0110	C826
Shift 4	0110	0100	0001	0011	6413

Flag is 0,	Shift 5	0011	0010	0000	1001	3209	
Flag is 1,		1010	0000	0000	0001	A001	
1001			0010	0000	1000		9208
Shift 6		0100	1001	0000	0100		4904
Flag is 0,	Shift 7	0010	0100	1000	0010	24B2	
Flag is 0,	Shift 8	0001	0010	0100	0001	1241	

Final CRC is X"13" 12 41 07 02 0001 0010 0100 0001 0000 0111 0000 0010 : Transmission

order ==> : ....last bit transmitted transmitted

Floating Point Representation for EUHI

The standard format for numbers to be transmitted over a MODBUS communication link allows for user selectable ranges although typically one of 4 are used: 0-999, 0-4095, 0-9999, and 0-65,534. In certain applications, this does not allow sufficient rangeability. Therefore, a special format is been defined for use with certain HOST computer hardware and software combinations. This format is used to communicate the engineering units range limits.

This format is a degenerate form of the IEEE floating point format implemented in a 16-bit word. The binary form is:

seee eeem mmmm mmmm

where:

s = the sign of the number

e^{6} = the exponent of the base two + 3110

m^{9} = the mantissa of the number in the form $1.mmmmmmmmm_2$

for all values equal to or above $1.*2^{-30}$

For smaller values,

e^{6} = reset and the mantissa will then be in the form

$0.mmmmmmmmm_2$ or less while the exponent will remain at 2^{-30}.

The case of e^{6} = "all set" is reserved for the "Bad PV" indicator. Therefore, the largest number that can be represented is:

$2*2^{32} - 1 = 4.295 * 10^{9}$.

Section 4. Host Computer Communications Interface (Hiway)

Contents

4.1 General

This section presents an application of the HOST Computer Communication Interface - HIWAY (HCI-H) with the OPTICHROM ADVANCE® system.

Subsection 4.2 pertains only to the communication link between a HOST computer and HCI-H board.

Subsection 4.3 pertains only to the communication between the HCI-H and some number of chromatographs, or other devices.

The HCI-H will act as an interpreter between the HOST and the OPTICHROM® analyzer(s). This is accomplished by reformatting the HOST message format into the OPTICHROM ADVANCE® Data Hiway (DH) format, and conversely, reformatting the DH message format into the HOST Message format.

The HOST must be connected to a unique HCI-H board, which in turn is connected to the DH. Likewise, each analyzer (device) must be connected to the DH.

The HOST/Analyzer communications allow for the following functions to be performed:

1) The HOST may perform diagnostic testing of the HOST/HCI-H interconnection.
2) The HOST may selectively set/read digital status information in one or more analyzers.
3) The HOST may selectively set/read analog data in one or more analyzers.
4) The HOST may set digital/analog data into all analyzers data bases.
5) The HOST may set the clock in all analyzers.

4.2 General (HOST/HCI-H)

Information in this subsection pertains only to the communication link between a HOST computer and a HCI-H (item number 2000130-004).

4.2.1 Communication Format

Communication between a HOST and the HCI-H board is serial, asynchronous by character, synchronous by bit, at a minimum rate of 110 baud and a maximum rate of 9600 baud.

The default communication baud rate is 9600 baud.

Each character will contain 11 sequential bits in the following order:

1	Start bit	First
8	Data bits	
1	Partiy bit (odd)	
1	Stop bits	Last

4.2.2 Communication Structure

Communication on the serial communication link is formatted into messages. There are eight (8) basis message types (see subsection 4.2.3.4):

Message (10) (16) Originator Description

1 1 01 Both HOST reads digital data from HCI-H. 2 2 02 Both HOST reads digital data from HCI-H. 3 3 03 Both HOST reads analog data from HCI-H. 4 4 04 Both HOST reads analog data from HCI-H. *5 5 05 Both HOST writes digital data to HCI-H. *6 6 06 Both HOST writes analog data to HCI-H. *7 102 66 Both HOST writes analog data to HCI-H. 8 8 08 Both HOST reads loopback data from HCI-H. All of these messages are used in the poll/response form, i.e., two parts:

1) a poll from HOST to HCI-H,

2) followed by a response * from HCI-H to HOST. *messages 5, 6, and 7 may be issued by the HOST as broadcast messages (system address 0), in which case the HCI-H will not send a response.

In any given application, two or more of these message types may be used as required.

Subsection 4.2.3.1 describes the general protocol for all message items.
Subsection 4.2.3.2 describes the HOST message protocol.
Subsection 4.2.3.3 describes the HCI-H message protocol,
Subsection 4.2.3.4 describes the structure of each type of message.
Subsection 4.2.3.5 contains miscellaneous information.

4.2.3.1 General Message Protocol

All messages are transmitted in binary with no reserved protocol characters.

A poll or response consists of:

1) The synchronization period 2) The Address byte 3) The Function byte 4) The information bytes 5) The CRC bytes 6) The synchronization period

The synchronization period is a period of three character times of quiet on the HOST/HCI-H communication line.

The Address and Function fields are one byte each. The CRC field is two bytes.

POLL Message

The information field consists of a two byte starting point, and:

a) two byte 'count' field for a READ function (multiple locations). b) two byte 'value' field for a WRITE function (single location).

RESPONSE Message

The information field consists of a variable number of elements, controlled by the Function code. a) For digital data, an element is 1 byte in length and contains up to 8 data items,

b) For analog data, an element is 2 bytes in length and contains 1 data item. The CRC used is the CRC-16 Generating Polynomial division method. Whenever a poll or response portion of a message received by the HOST or HCI-H is in error, it should be ignored.

a. One or more bytes contain parity, framing, or device overrun errors.
b. CRC generated does not equal CRC received.
c. Message format is violated.

4.2.3.2 HOST Message Protocol

There are eight (8) basic message types (see subsection 4.2.3.4) that are legal for the HOST to initiate: Message (10) (16) Description

1 2	1 2	01 02	HOST wishes to obtain digital status from one or more analyzers.
3 4	3 4	03 04	HOST wishes to obtain analog information from one or more analyzers.

*5	5	05	HOST wishes to send digital status information to one or more analyzers.
*6	6	06	HOST wishes to send analog information to one or more analyzers.
*7	102	66	
8	8	08	HOST desires to perform 'loopback' diagnostic testing of the HCI-H communications interface.

Messages 1, 2, 3, 4 and 8 will always trigger a response from the addressed HCI-H, provided the message is received without errors and it contains valid information. Valid addresses are 1 through 255.

Messages 5, 6 and 7 may or may not trigger a response from the addressed HCI-H.

Valid addresses are 0 through 255. Address 0 is considered to be a broadcast message to all HCI-H boards in the system.

4.2.3.3 HCI-H Message Protocol

There are eight (8) good data message types, and one hundred twenty-seven (127) exception message types that are legal for the HCI-H to initiate (see subsection 20.2.3.4). All are response messages to a poll from the HOST.

Message (10) (16)	Description
1 1 01	HCI-H sends digital status information one or more analyzers.
2 129 81	HCI-H sends the exception response for code X'0''.
3 2 02	HCI-H sends digital status information from one or more analyzers.
4 130 82	HCI-H sends the exception response for code X'02'.
5 3 03	HCI-H sends analog information from one or more analyzers.
6 131 83	HCI-H sends the exception response for X'03'.
7 4 04	HCI-H sends analog information from one or more analyzers.
8 132 84	HCI-H sends the exception response for code X104'.

Message (10) (16) Description

9 5 05 HCI-H acknowledges receipt of digital status information for one or more analyzers. 10 133 85 HCI-H sends the exception response for code X'05'.

11 6 06 HCI-H acknowledges receipt of analog information for one more analyzers. 12 134 86 HCI-H sends the exception response for code Xl'06'.

13 102 66 HCI-H acknowledges receipt of analog information for one or more analyzers. 14 230 E6 HCI-H sends the exception response for code X'66'.

15 8 08 HCI-H acknowledges 'loopback' diagnostic testing of the HCI-H communications link. 16 136 88 HCI-H sends the exception response for code X'08'.

17 128 80 HCI-H sends the exception response for code X'00'.
18 135 87 HCI-H sends the exception response for code X'07'.
19 137 89 HCI-H sends the exception response for code X'09'.
::
::
111 229 E5 HCI-H sends the exception response for code X'65'.

112 231 E7 HCI-H sends the exception response for code X'67'.
::
135 255 FF HCI-H sends the exception response for code X'7F'.

The address byte will always contain the HCI-H's hardware strapped address. Valid addresses are 1 through

255.

The Function byte will contain either the received Function code (good response) or it will contain the received Function code OR'ED with X'80 (exception response).

Exception responses will be generated if the poll message was received from the HOST without error but either the Function code or information field(s) was invalid.

4.2.3.4 Message Types

The eight message types listed in subsection 4.2.2 are described in detail in the following subsections.

NOTE

The examples may or may not illustrate a valid starting address, they are provided, and should be used, for illustration only.

4.2.3.4.1 Function Code X'01' (Read OUTPUT Status: 0XXXX, XXXX = 0001 - 9920)

This function allows the HOST to obtain the ON/OFF status of logic coils used to control discrete outputs (i.e., coils (0XXXX) from the addressed HCI-H. In addition to the address and function fields, the message syntax requires that the information field contain the initial coil number to be read (Starting Number) and the number of locations that will be interrogated to obtain status data: any number from 1 to 2000.

The following example shows a read output status request to read coils 1667 to 1682 from HCI-H system address 1.

HOST poll:

System Address	Function Code	Start Coil		Count of Coils		CRC Bytes
01	01	06	82	00 10	9D	66

HCI-H good response:

System Address	Function Code	Byte Count	-----Output Col.---- Status	CRC Bytes

1674-1667 1682-1675 01 01 02 01 00 hhhh The last

Coil Status element is padded from the left with zeroes to force right justification of the status

coil(s) of interest.

This reply would indicate that ANLZ #1 has been placed in hold by the HOST computer.

HCI-H exception response:

System Function Error CRC

Address Code Code Bytes

01	81	0X	hh	hh

Error Codes:

X'02'	Illegal Start Coil	The Coil referenced in the data field is not an allowable coil.
X'03'	Illegal Data Value	The count of coils specified would require referencing an invalid data address.

4.2.3.4.2 Function Code X'02' (Read 'READ ME' Bits: 1XXXX, XXXX = 1001 - 9255)

This function allows the HOST to obtain the ON/OFF status of discrete inputs (i.e., coils (1XXXX) in the addressed HCI-H. In addition to the address and function fields, the message syntax requires that the information field contain the initial coil number to be read (Starting Number) and the number of locations that will be interrogated to obtain status data: any number from 1 to 2000.

The following example shows a read input status request to read inputs 11001 to 11016 from HCI-H system address 1.

HOST poll:

System Address	Function Code	Start Coil		Count of Coils		CRC Bytes
01	02	03	E8	00 10	F9	86

HCI-H good response:

System Address	Function Code	Byte Count	-----Discrete---- Inputs	CRC Bytes

11008-11001 11016-11009 01 02 02 01 00B828 The last Discrete Input element is padded from the left with zeroes to force right justification of the Input(s)

of interest.

This reply would indicate that AX-1 STRM-1 Read Me bit is set and AZ-2 - 16 STRM-1 Read me bits are not

set.

HCI-H exception response:

System Function Error CRC

Address Code Code Bytes

01	82	0X	hh	hh

Error Codes:

X'02'	Illegal Start Coil	The Coil referenced in the data field is not an allowable coil.
X'03'	Illegal Data Value	The count of coils specified would require referencing an invalid data address.

4.2.3.4.3 Function Code X'03' (Read OUTPUT Registers: 4XXXX, XXXX = 0001 - 9999)

This function allows the HOST to obtain the binary contents of holding registers (i.e., registers 4XXXX) from the addressed HCI-H. In addition to the address and function fields, the message syntax requires that the information field contain the initial register number to be read (Starting Number) and the number of registers that will be interrogated: any number from 1 to 125.

The following example shows a read output register request to read registers 41101 to 41103 from HCI-H system address 01.

This being STRM-1 Component-1 ANLZ 1 -3

HOST poll:

System Function Start Number of CRC
Address Code Register Registers Bytes

01 03 04 4C00 03 C52C HCI-H good response: System Function Byte --------Output---------

CRC

Address Code Count Registers Bytes

41101 41102 41103 01 03 06 022C00000064hhhh The

Output Registers contain the decimal values 556, 0, and 100 respectively. HCI-H exception

response: System Function Error CRC

Address Code Code Bytes

01 83 0X hhhh Error Codes: X'02' Illegal Start Number The register referenced in the data field

is not an allow

able register.

X'03' Illegal Data Value The count of registers specified would require referencing an invalid data address.

4.2.3.4.4 Function Code X'04' (Read INPUT Registers: 3XXXX, XXXX = 0001 - 9558)

This function allows the HOST to obtain the binary contents of input registers (i.e., registers 3XXXX) from the addressed HCI-H. In addition to the address and function fields, the message syntax requires that the information field contains the initial register number to be read (Starting Number) and the number of registers that will be interrogated: any number from 1 to 125.

The following example shows a read input register request to read registers 3008 to 30010 from HCI-H system address 01.

HOST poll:

System Function Start Number of CRC
Address Code Register Registers Bytes

01 04 00 0700 0301CA HCI-H good response: System Function Byte --------Input---------CRC

Address Code Count Registers Bytes

30008 30009 30010 01 04 06 024610000876hhhh The Input Registers contain the decimal values 582, 4096 and 2166 respectively. HCI-H exception response: System Function Error CRC

Address Code Code Bytes

01 84 0X hhhh Error Codes: X'02' Illegal Start Number The register referenced in the data field is not an allow

able register #.

X'03' Illegal Data Value The count of registers specified would require referencing an invalid data address.

4.2.3.4.5 Function Code X'05' (Force OUTPUT Coil: 0XXXX, XXXX = 0001 - 9920)

This function allows the HOST to force a single internal or output coil (i.e., coil 0XXXX) in the

addressed HCI-H either ON or OFF. In addition to the address and function fields, the message syntax requires that the information field contain the coil address to be modified and the corresponding data value (X'FF00' will set the coil ON, X'0000' will set the coil OFF: all other values are illegal and will not affect that coil).

The following examples shows a force coil 01667 'ON' in HCI-H system address 01. This example would place AX-1 in Hold.

HOST poll:

System Function Coil Data CRC
Address Code Number Value Bytes

01 05 06 82FF 00 2C9A HCI-H good response: System Function Coil Data

CRC Address Code Number Value Bytes

01 05 0682 FF00 2C9A HCI-H exception response: System Function Error CRC

Address Code Code Bytes

01 85 0X hhhh Error Codes: X'02' Illegal Coil Number The Coil referenced in the data field is

not an allowable

coil #.

X'03' Illegal Data Value The value specified is not valid.

X'04' Failure in HCI-H There is some failure in the ADVANCE

system that pre

vents completion of the desired action.

4.2.3.4.6 Function Code X'06' (Preset Holding Register: 4XXXX, XXXX = 0001 - 9999)

This function allows the HOST to modify a single Holding Register (i.e., register 4XXXX) in the addressed HCI-H. In addition to the address and function fields, the message syntax requires that the information field contain the register number to be modified and the corresponding data value (X'hhhh'; 16 bit binary, unused high order bits must be set to zero).

The following example shows a preset register request to load register 40033 in HCI-H system address 01.

HOST poll:

System Address	Function Code		Register Number		Data Value		CRC Bytes
01	06	00	20	75	30	AE	84

HCI-H good response:

System Address	Function Code	Start Coil	Count of Coils	CRC Bytes

01 06 0020 75 30 AE84

This function sets the system real time clock to 30 secs (3000 milliseconds) and the HCI-H broadcasts to
the analyzers on the seconds set.

HCI-H Exception Response:

System Function Error CRC

Address Code Code Bytes

01	86	0X	hh	hh

Error Codes:

X'02'	Illegal Register #	The Register referenced in the data field is not an allowable register #.
X'03'	Illegal Data Value	The value specified is not valid.
X'04'	Failure in HCI-H	There is some failure in the Advance system that prevents completion of the desired action.

4.2.3.4.7 Function Code X'66' (Preset input Register: 3XXXX, XXXX = 0001 - 9558)

This function allows the HOST to modify a single Input Register (i.e., register 3XXXX) in the addressed HCI-H. In addition to the address and function fields, the message syntax requires that the information field contain the register number to be modified and the corresponding data value (X'hhhh'; 16 bit binary, unused high order bits must be set to zero).

The following example shows a preset register request to load register 31255 in HCI-H system address 01.

HOST poll:

System Function Register Data CRC

Address Code Number Values Bytes

01 66 04 E64B 20 DE20 HCI-H good response: System Function Register
Data CRC Address Code Number Values Bytes

01 66 04E6 4B 20 DE20 This message will set the EUHI for AX-1 Component-1 to 100. HCI-H exception response: System Function Error CRC

Address Code Code Bytes

01 E6 0X hhhh Error Codes: X'02' Illegal Register # The Register referenced in the data field is not an allow

able register #.

X'03' Illegal Data Value The value specified is not valid.

X'04' Failure in HCI-H There is some failure in the ADVANCE system that pre

vents completion of the desired action.

4.2.3.4.8 Function Code X'08' (Loopback Test)

This function allows the HOST to test the communication system to/from the addressed HCI-H. In addition to the address and function fields, the message syntax requires that the information field contain the diagnostic code and the corresponding data value.

Diagnostic Code 0:

The following example shows a 'loopback test' request for the HCI-H system address 18 to return the data field X'DEAD'.

HOST poll:

System Address	Function Code		Diagnostic Code		Data Value		CRC Bytes
01	08	00	00	DE	AD	78	16

HCI-H good response:

System Address 01	Function Code 08	Diagnostic Code 00 00	Data Value DE	AD 78	CRC Bytes 16

HCI-H exception response:

System Address	Function Code	Error Code	CRC Bytes
01	88 0X hh		hh

Error Codes:

X'03'	Illegal Data Value	The Diagnostic code specified is not valid.

Diagnostic Code 1:

The following example shows a 'loopback test' request for the HCI-H at system address 01 to reset the
communication port (perform a full Restart function).
The HCI-H will send its response message to the HOST, then do the requested Restart.

HOST poll:
System Function Diagnostic Data CRC
Address Code Code Value Bytes

01 08 00 0100 00 B1CB

HCI-H good response:

System Address	Function Code	Diagnostic Code	Data Value	CRC Bytes

01 08 0001 00 00 B1CB

4.2.3.4.9 Invalid Function Codes X'nn'

When a message is received from the HOST with a good CKSM and an invalid Function Code, the HCI-H will ignore the request and respond to the HOST with an Exception message.

HCI-H exception response:

System Function Error CRC Address Code Code Bytes

12 nn 01 hh hh

Error Codes:

X'0"	Illegal function	The received message Function code is not an allowable function.

4.2.3.5 HCI-H Memory Layout, Definitions

A digital memory location contains exactly 1 bit of information.

An Analog memory location contains 1 item of analog information and is exactly 16 bits in size.

The HOST uses absolute decimal numbers (addresses) to access the desired memory locations.

Addresses Memory Definitions

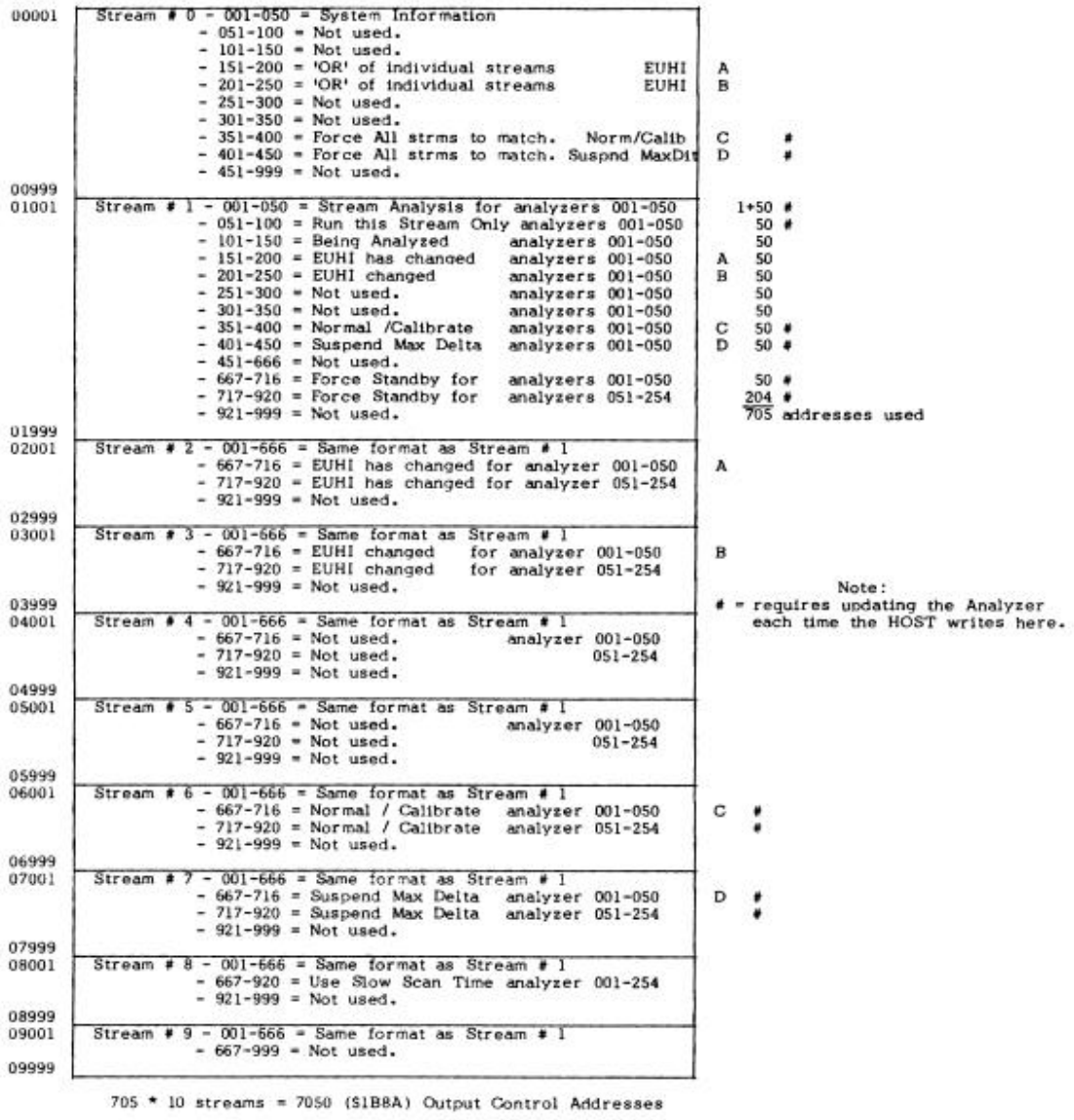
00001 - 00999 Stream # 0 Digital (Coil) OUTPUT Control 01001 - 01999 Stream # 1 02001 - 02999 Stream # 2 accessed via Function Codes 03001 - 03999 Stream # 3 04001 - 04999 Stream # 4 x'01 (READ) and 05001 - 05999 Stream # 5 x'05' (WRITE) 06001 - 06999 Stream # 6 07001 - 07999 Stream # 7 08001 - 08999 Stream # 8 09001 - 09999 Stream # 9

10001 - 10999 Stream # 0 Digital (Coil) READ ME Bits 11001 - 11999 Stream # 1 12001 - 12999 Stream # 2 accessed via Function Code 13001 - 13999 Stream # 3 14001 - 14999 Stream # 4 x'02' (READ) 15001 - 15999 Stream # 5 16001 - 16999 Stream # 6 17001 - 17999 Stream # 7 18001 - 18999 Stream # 8 19001 - 19999 Stream # 9

30001 - 30999 Stream # 1 Component # 0 Analog (Register) INPUT Value 31001 - 31999 Stream # 1 Component # 1 32001 - 32999 Stream # 1 Component # 2 accessed via Function Codes 33001 - 33999 Stream # 1 Component # 3 34001 - 34999 Stream # 1 Component # 4 x'04 (READ) and 35001 - 35999 Stream # 1 Component # 5 x'66 (WRITE) 36001 - 36999 Stream # 1 Component # 6 37001 - 37999 Stream # 1 Component # 7 38001 - 38999 Stream # 1 Component # 8 39001 - 39999 Stream # 1 Component # 9

40001 - 40999 Stream # 0 Analog (Register) OUTPUT value 41001 - 41999 Stream # 1 42001 - 42999 Stream # 2 accessed via Function Codes 43001 - 43999 Stream # 3 44001 - 44999 Stream # 4 x'03' (READ) and 45001 - 45999 Stream # 5 x'06 (WRITE) 46001 - 46999 Stream # 6 47001 - 47999 Stream # 7 48001 - 48999 Stream # 8 49001 - 49999 Stream # 9

4.2.3.5.1 Digital Memory Layout, Definitions - Digital (Coil) Output Control



4.2.3.5.1a Individual Coil Assignments

Stream 0 System Information

Address	Description	Set By	Reset By
00001	Not Used		
00002	Pwr Up procedure just completed	HCI-H	HOST
00003 00008	Noted		
00009	HOST alive	HOST	HCI-H

00010	System Data Base Change	HCI-H	HOST
00011	Suspend Maximum Change Test	HOST	HOST
00012 00050	Not Used		
00051 00100	Not Used		
00101 00150	Not Used		
00151 00200	EUHI has changed for some component Logical 'OR' of individual streams	HCI-H	HOST
00201 00250	EUHI has changed in this stream Logical 'OR' of individual streams	HCI-H	HOST
00251 00350	Not Used		
00351 00400	Run Calibration, this stream Force individual streams to match	HOST	HCI-H
00401 00450	Suspend Maximum Change Test Force individual streams to match	HOST	HCI-H
00451 00999	Not Used		

4.2.3.5.1b Individual Coil Assignments

Stream 1 System Information

Address	Description	Set By		Reset By
01001 01050	Skip Stream Analysis	Both	Both	RSLT 6,7
01051 01100	Run on this stream, HOST Force Standby, all other streams	HOST		
01101 01150	Stream currently being analyzed	HCI-H	HCI-H	RSLT 12
01151 01200	EUHI has changed for some component	HCI-H	HOST	
01201 01250	EUHI has changed in this stream	HCI-H	HOST	
01251 01350	Not Used			

01351 01400	Run Calibration, this stream	HOST	HCI-H
01401 01450	Suspend Maximum Change Test	HOST	HOST
01451 01666	Not Used		
01667 01920	Run only this stream, Force Standby, all other streams	HOST	HOST

4.2.3.5.1c Individual Coil Assignments

Streams 2 - 9 Stream information

Address	Description	Set By	Reset By
0x001 0x666	Same description as Stream 1 above		
02667 02920	EUHI has changed for some component	HCI-H	HOST
03667 03920	EUHI has changed in this stream	HCI-H	HOST
04667 04920	Not Used		
05667 05920	Not Used		
06667 06920	Run Calibration, this stream	HOST	HCI-H
07667 07920	Suspend Maximum Change Test	HOST	HOST
08667 08920	Operate in slow concentration scan time mode	HOST	HOST
09667 09920	Not used		

4.2.3.5.2 Digital Memory Layout, Definitions - Digital (Coil) READ ME Bits 4.2.3.5.3 Analog Memory Layout, Definitions - Analog (Register) Input Value

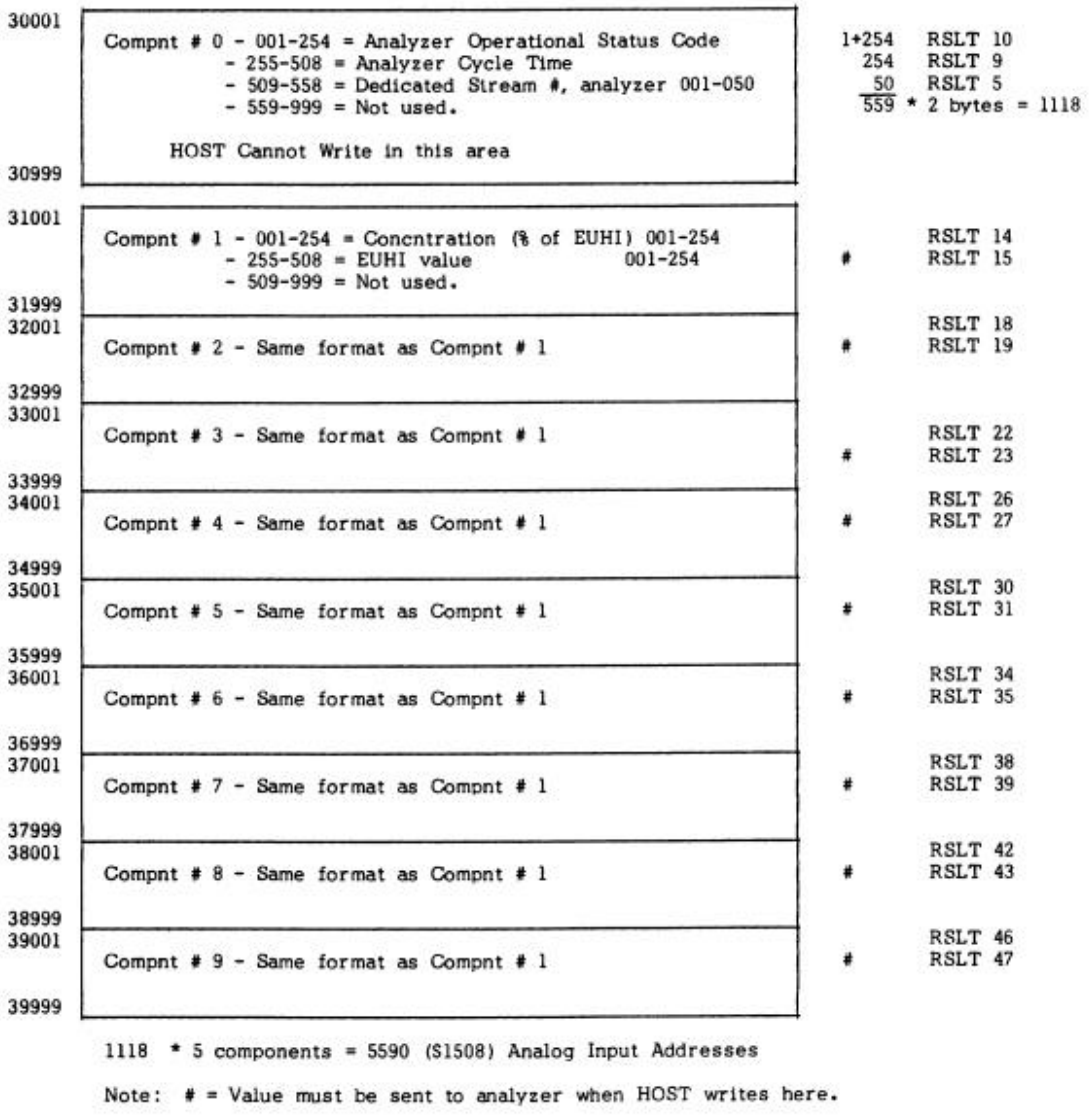
Bits are Set and Reset by the HCI-H

HOST cannot Write

10001	Stream # 0 - Not used.	
10999		
11001	Stream # 1 - 001-050 = read me bit for analyzer 001-050 - 051-254 = read me bit for analyzer 051-254 - 255-999 = Not used.	1+50 204 255
11999		
12001	Stream # 2 - 001-050 = read me bit for analyzer 001-050 - 051-254 = Not used. - 255-999 = Not used.	
12999		
13001	Stream # 3 - Same format as Stream # 2	
13999		
14001	Stream # 4 - Same format as Stream # 2	
14999		
15001	Stream # 5 - Same format as Stream # 2	
15999		
16001	Stream # 6 - Same format as Stream # 2	
16999		
17001	Stream # 7 - Same format as Stream # 2	
17999		
18001	Stream # 8 - Same format as Stream # 2	
18999		
19001	Stream # 9 - Same format as Stream # 2	
19999		

255 * 10 streams = 2550 ($09F8) READ ME bit Addresses

Stream 1 Data, Components 0 - 9



1118 * 5 components = 5590 ($1508) Analog Input Addresses

Note: # = Value must be sent to analyzer when HOST writes here.

4.2.3.5.3a Individual Register Assignments

Component 0 Analog Operational Status

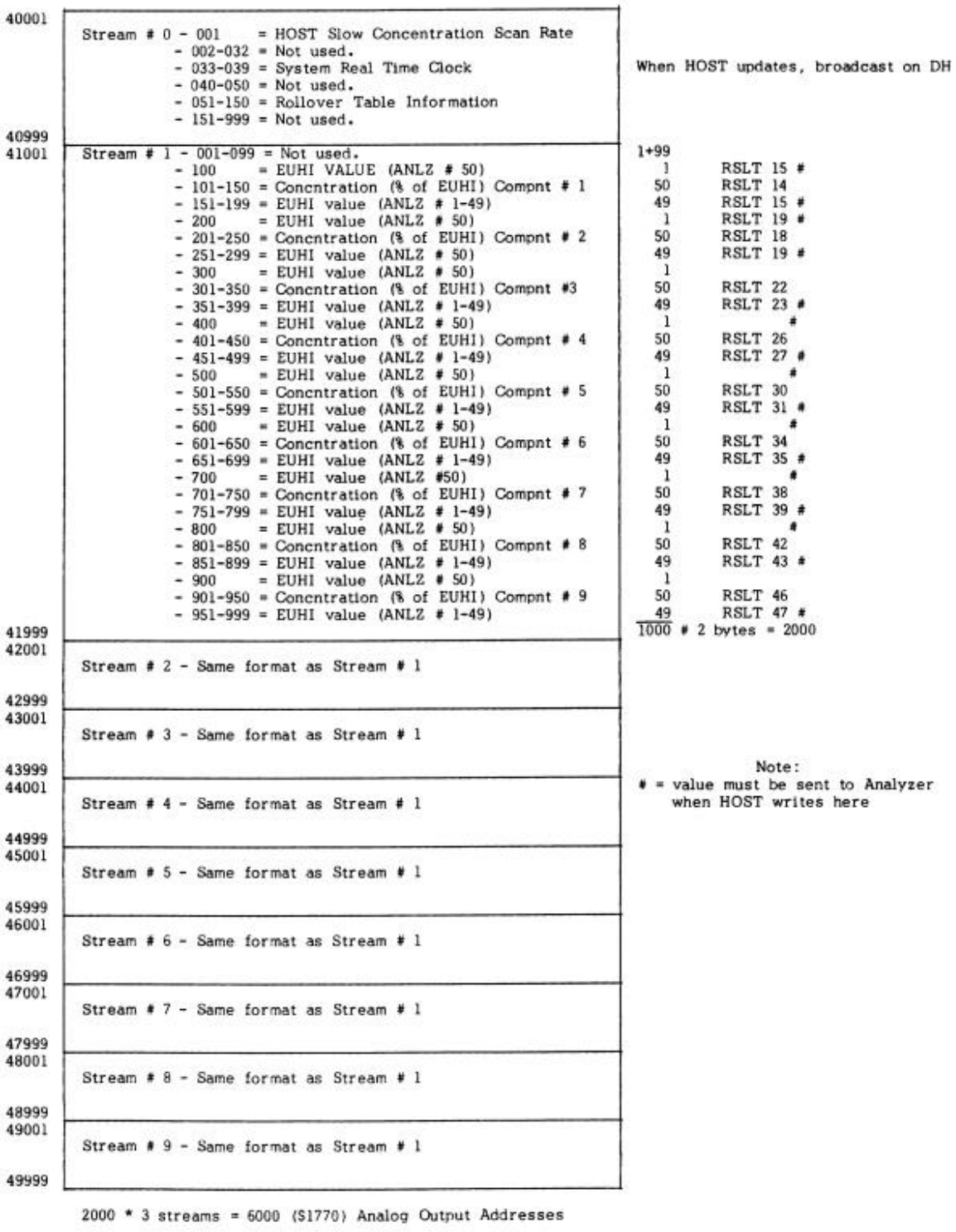
Address	Description	Written By
30001 30254	Analyzer Operational Status Code	HCI-H
30255 30508	Analyzer Cycle Time	HCI-H
30509 30558	Stream #, if stream 1 - 50 running a dedicated stream	HCI-H

30559 30999	Not Used	

Component 1 Component Measurement Information

Address	Description	Written By
31001 31254	Component Concentration, expressed as a percentage of EUHI	HCI-H
31255 31508	Component EUHI Value	HCI-H or HOST
31509 31999	Not Used	

4.2.3.5.4 Analog Memory Layout, Definitions - Analog (Register) Output Value



4.2.3.5.4a Individual Register Assignments

Stream 0 System Data

Address	Description	Written By

40001	HOST Slow Concentration Scanning Rate for Component Concentrations	HOST
40002 40032	Not Used	
40033 40039	System Real Time Clock	HOST
40040 40050	Not Used	
40051 40150	Rollover	
40151 40999	Not Used	HCI-H

Stream 1 Composition Information, Analyzers 1 - 50

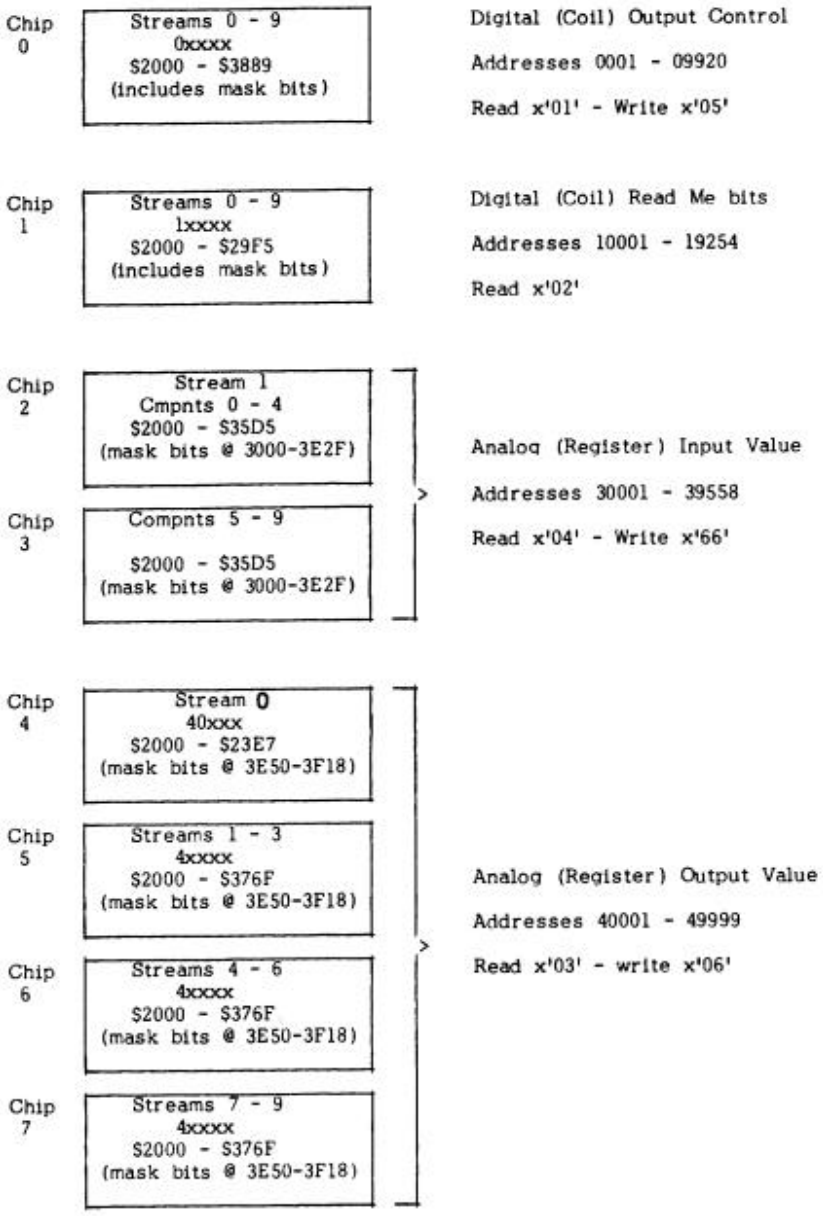
Address	Description	Written By
41001 41099	Not Used	
41100 41101 41150 41151 41199	Component 1 EUHI value (ANLZ # 50) Component 1 Concentration, expressed as a percentage of EUHI Component 1 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST
41200 41201 41250 41251 41299	Component 2 EUHI value (ANLZ # 50) Component 2 Concentration, expressed as a percentage of EUHI Component 2 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST
41300 41301 41350 41351 41399	Component 3 EUHI value (ANLZ # 50) Component 3 Concentration, expressed as a percentage of EUHI Component 3 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST

Stream 1 Composition Information, Analyzers 1 -50 continued

Address	Description	Written By
41400 41401 41450 41451 41499	Component 4 EUHI value (ANLZ #50) Component 4 Concentration, expressed as a percentage of EUHI Component 4 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST

41500 41501 41550 41551 41599	Component 5 EUHI value (ANLZ # 50) Component 5 Concentration, expressed as a percentage of EUHI Component 5 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST
41600 41601 41650 41651 41699	Component 6 EUHI value (ANLZ # 50) Component 6 Concentration, expressed as a percentage of EUHI Component 6 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST
41700 41701 41750 41751 41799	Component 7 EUHI value (ANLZ # 50) Component 7 Concentration, expressed as a percentage of EUHI Component 7 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST
41800 41801 41850 41851 41899	Component 8 EUHI value (ANLZ # 50) Component 8 Concentration, expressed as a percentage of EUHI Component 8 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST
41900 41901 41950 41951 41999	Component 9 EUHI value (ANLZ # 50) Component 9 Concentration, expressed as a percentage of EUHI Component 9 EUHI value (ANLZ # 1-49)	HCI-H or HOST HCI-H HCI-H or HOST

4.2.3.5.4b 'BIGRAM' Memory Layout 4.2.3.5.4c 'TOR' RESULTs Definitions


Chip 0
Streams 0 - 9
0xxxx
$2000 - $3889
(includes mask bits)
Digital (Coil) Output Control
Addresses 0001 - 09920
Read x'01' - Write x'05'
Chip 1
Streams 0 - 9
1xxxx
$2000 - $29F5
(includes mask bits)
Digital (Coil) Read Me bits
Addresses 10001 - 19254
Read x'02'
Chip 2
Stream 1
Cmpnts 0 - 4
$2000 - $35D5
(mask bits @ 3000-3E2F)
Chip 3
Compnts 5 - 9
$2000 - $35D5
(mask bits @ 3000-3E2F)
Analog (Register) Input Value
Addresses 30001 - 39558
Read x'04' - Write x'66'
Chip 4
Stream 0
40xxx
$2000 - $23E7
(mask bits @ 3E50-3F18)
Chip 5
Streams 1 - 3
4xxxx
$2000 - $376F
(mask bits @ 3E50-3F18)
Chip 6
Streams 4 - 6
4xxxx
$2000 - $376F
(mask bits @ 3E50-3F18)
Chip 7
Streams 7 - 9
4xxxx
$2000 - $376F
(mask bits @ 3E50-3F18)
Analog (Register) Output Value
Addresses 40001 - 49999
Read x'03' - write x'06'

RSLT 1	ANLZ Number	Used for 'xxx' addressing	
RSLT 2	Number of STREAMs Reporting	Rollover Table calculations	
RSLT 3	Max number of Components per Stream	Rollover Table calculations	
RSLT 4	Present Stream # reporting	Used for 's' addressing	
RSLT 5	Dedicated Stream number	30xxx (xxx = 509-558)	ANLZs 1-50
RSLT 6	Stream Mask - MS bytes (Streams 32-17)	0sxxx (s = 1-9; xxx = 001-050)	ANLZs 1-50
RSLT 7	Stream Mask - LS bytes (Streams 16-1)	1=Enabled, 0=Disabled	
RSLT 8	Number of Seconds until next report	HCI-H SPAD	
RSLT 9	Cycle time, Fractional	30xxx (xxx = 255-508)	ANLZs 1-254
RSLT 10	Analyzer Status	30xxx (xxx = 001-254)	ANLZs 1-254
RSLT 11	Analyzer Fraction, Full Scale	HCI-H SPAD	
RSLT 12	Stream Being Analyzed (0-32)	0sxxx (s = 1-9, xxx = 101-150)	ANLZs 1-50
RSLT 13	As analyzed Analyzer Status	ignored by HCI-H	
RSLT 14	Component 1 - Concentration	3cxxx (c = 1-9; xxx = 001-254)	ANLZs 1-254
		4scxx (s,c = 1-9; xx = 01-50)	ANLZs 1-50
RSLT 15	Component 1 - EUHI	3cxxx (c = 1-9; xxx = 255-508)	ANLZs 1-254
		4scxx (s,c = 1-9; xx = 51-99,00)	ANLZs 1-50
RSLT 16	Component 1 - Max change limit	ignored by HCI-H	
RSLT 17	Component 1 - Min change limit	ignored by HCI-H	
RSLT 18	Component 2 - Concentration		
RSLT 19	Component 2 - EUHI		
RSLT 20	Component 2 - Max change limit		
RSLT 21	Component 2 - Min change limit		
RSLT 22	Component 3 - Concentration		
RSLT 23	Component 3 - EUHI		
RSLT 24	Component 3 - Max change limit		
RSLT 25	Component 3 - Min change limit		

Bischoff Analysentechnik GmbH
Taunusstr. 27, 61267 Neu Anspach
Phone 004960819444070, Fax 004960819444071