

Isotech Calibration Baths and Furnaces: Protocol

Software to communicate with Isotech Calibration Baths includes, Isotech Mercury, Isotech CalNotePad and the VLT Automation System.

This document is for those who wish to write their own software.

Calibration Baths and Furnaces produced by Isothermal Technology currently use Eurotherm EiBisynch Protocol.

Note: The Isotech High Stability Controller uses a different protocol, details available on request. This Isotech High Stability Controller is used with some versions of the Parallel Tube Liquid Bath, Model 915.

EI BISYNCH PROTOCOL

If you wish to write your own software you will need to ensure that the requirements of the Eurotherm EI Biysnch protocol are met. Full technical details follow.

For users of National Instruments LabVIEW we have drivers available which handle the protocol. We also have drivers for our TTI 1 and TTI 2 temperature indicators.

If you are a LabVIEW or CVI user and a customer of Isotech we can make these drivers available for you.

Send the email to info@isotech.co.uk along with the serial number of your Isotech equipment and we will email driver by return. If you do not have email please contact the factory.

Eurotherm EI-Bisynch Protocol

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This chapter introduces the principles of the EI-Bisynch communication protocol. EI-Bisynch is a proprietary Eurotherm protocol based on the ANSI X3.28-25 A4 standard for message framing. Despite its name, it is an ASCII based asynchronous protocol. **Data is transferred using 7 data bits, even parity, 1 stop bit.**

Explanation of Terms

Address

Each instrument has a configurable address consisting of two digits, the first being a 'group' number 0 to 9 and the second a unit number 0 to 9. There are, in principle, therefore 100 different addresses that may be used, 00 to 99, although in Series 2000 instruments, address 00 is reserved for use in configuration mode, leaving addresses 01 to 99 available.

The address is set on the 'Cms' menu, using the 'Addr' parameter.

Mnemonics

EI-Bisynch identifies parameters within an instrument using what are known as 'mnemonics'. These are usually two letter abbreviations for a given parameter, for example PV for Process Variable, SP for Setpoint, SL for Local Setpoint. [Although there are other parameters they will not be needed for the remote control of Isotech calibration baths], SP is read only - SL may be written to.

Channels [Not required for Isotech Calibration Baths]

EI-Bisynch provides for 'channel' data. This would be used, for example, when a single physical unit contains several independent control loops, each having their own Process Variable and Setpoint. In this case, the values for each loop are obtained by specifying different channel number: '1', '2', etc.

The 2000 Series supports an optional channel number of '1', since it is a single loop controller. Other channel numbers will be rejected as invalid, with the exception of channel '9' which has specialised function described elsewhere in this manual.

The channel number, if used, is encoded as a single ASCII character preceding the mnemonic, for example 1PV.

Control Characters

Several ASCII control characters are used in the framing of EI-Bisynch messages. These are:

HEX VALUE	NAME	USAGE

02	STX	Start of data in a message
03	ETX	End of message
04	EOT	End of transmission sequence
05	ENQ	Enquiry for a value
06	ACK	Positive Acknowledge
15	NAK	Negative Acknowledge

Data Formats

Data in Bisynch messages is sent as a sequence of ASCII printable characters. Two principle data formats are used in Series 2000 instruments, free format, and hex format.

Free Data Format

Parameter values returned from the instrument in 'free format' are of variable length. The instrument returns the value as it would be displayed on its front panel, with no leading or trailing spaces, e.g:

```
--99.9
123.4
123 (integer value)
```

Note that trailing decimal point characters are suppressed. Any 'sign' must precede the number itself.

Values written to the instrument may contain leading and trailing spaces, leading or trailing zeros, or sign indications.

This format is used for almost all parameters available over EI-Bisynch in the 2000 Series, with the exception of a few status words and prime set parameters which use 'hex format'.

NB: Because the returned value is of variable length, it is necessary to use the terminating ETX character to delimit the data value. It is not usually possible to make assumptions regarding the number of characters used to represent a value unless you are operating in a very restricted numeric range, 10.0 to 99.9 for example, where all possible values will take 4 characters to transmit.

Hex Data Format [Not needed for Isotech Calibration Baths]

This format is used for a few status words and prime set parameters. The value is preceded by a '>' (hex 3E) character and normally consists of 4 hexadecimal characters, although it is acceptable to suppress leading zeroes when parameters are written. These characters represent the value of a 16 bit unsigned integer in hexadecimal (base 16) notation. Upper or lower case representations of 'A' to 'F' are acceptable, although the instrument will always return upper case. For example

BCC This a block checksum that is generated for data validation. It is computed by XORing (exclusive or) all the characters after and excluding the STX and **including** the ETX. Note this may take the value of `EOT' and care must be taken when writing a protocol driver to ensure that this is not seen as an `End of Transmission' sequence.

If a request is made for a non existent mnemonic, or a mnemonic representing a parameter that is not configured, the instrument will reply with a single `EOT' character. If there is no reply at all, one of the following errors is possible:

- Incorrect wiring or faulty hardware (Cable, PC, RS422/485 adaptor, Instrument Comms Module)
- Instrument Address set wrong (PC, Instrument)
- Wrong Line setup, should be 7 data bits, even parity, 1 stop (PC)
- Baud rate set wrongly (PC, Instrument)
- Parity error detected by instrument (Suspect line noise)
- Incorrect message format (PC)

To determine the cause of any communications problems, work systematically through the possible causes.

Example of a Parameter Read

For example, when reading PV from instrument address 1, the following sequence of characters will be sent and received:

Master: [EOT] 0011PV [ENQ]
Instrument: [STX] PV16.4 [ETX] {BCC}

Note that the BCC is a single character, that in this case has a value of 18 hex.

In hexadecimal, the transaction is as follows:

Master: 04 30 30 31 31 50 56 05
Instrument: 02 50 56 31 36 2E 34 03 18

Fast Poll

Fast polling provides a means of rapidly obtaining a set of parameter values, following an initial successful parameter read carried out as specified above. To read the next parameter in the 'fast poll' list, the master must send an 'ACK' control character following receipt of a valid poll response message, whereupon a reply message in the same format as the poll response will be received.

Parameters are only returned if they are configured and the order which parameters are returned sorted alphabetically by mnemonic excluding program segment data. The only real use of this facility is to build an image of the parameter database in an instrument and its use in other scenarios is not recommended.

Repeated Polling of the Same Parameter

This facility provides a means of repeatedly obtaining a particular parameter value, following an initial successful parameter read carried out as specified above. To repeat this last poll operation, the master should transmit a 'NAK' control character following receipt of a valid poll response message, whereupon a reply message in the same format as the poll response will be received.

Writing data to the 2000 Series

To write data, a 'select' message is issued to the instrument. This message takes the following format:

[EOT] (GID) (GID) (UID) (UID) **[STX]** (CHAN) (C1) (C2)<DATA>**[ETX]** (BCC)

Each item in the above description represents a single ASCII character. The items in bold type and square brackets are control characters used to 'frame' the message, whose values may be determined by reference to the table XX.XX above. The bracketed items in normal type have the following significance:

GID The group id, or the first digit of the instrument address. E.G. '1' (31 hex) for instrument address 12, '0' (30 hex) for instrument address 1 (which is equivalent to address 01). The GID is sent twice, as a validation mechanism.

UID The unit id, or the second digit of the instrument address. E.G. '2' (32 hex) for instrument address 12, '1' (31 hex) for instrument address 1. The UID is sent twice, as a validation mechanism.

CHAN The channel number, which is optional. If used, send a value of '1' for Series 2000 single loop controllers.

C1 The first character of the mnemonic for the parameter being accessed, e.g. 'P' for Process Variable.

C2 The second character of the mnemonic for the parameter being accessed, e.g. 'V' for Process Variable.

DATA The value of the parameter in a given display format. E.G. 99.9, 1.2, -999, >1234 etc.

BCC This is a block checksum that is generated for data validation. It is computed by XORing (exclusive or) all the characters after and **excluding** the STX and **including** the ETX.

If a parity of address format error is dedicated, the instrument will not reply. Otherwise, the instrument will reply with either:

[NAK] Failed to write: BCC is incorrect, or Parameter not available or not configured, or Parameter is read only, or attempt has been made to read a parameter that is outside limits. A read of the EE mnemonic will give more information.

[ACK] Parameter write was successful.

If there is no reply at all to a write request, one of the following errors is possible:

- Incorrect wiring or faulty hardware (Cable, PC, RS422/485 adaptor, Instrument Comms Module)
- Instrument Address set wrong (PC, Instrument)
- Wrong Line set up, should be 7 data bits, even parity, 1 stop (PC)
- Baud rate set wrongly (PC, Instrument)
- Parity error detected by instrument (Suspect line noise)
- Incorrect message format (PC)

To determine the cause of any communications problems, work systematically through the possible causes.

Example of a Parameter Write

For example, when writing a value of 22.0 to the setpoint to an instrument at address 1, the following sequence of characters will be sent and received:

Master: [EOT] 0011 [STX] SL22.0 [ETX] {BCC}

Instrument:

[ACK]

Note that the BCC is a single character, that in this case has a value of 32 hex.

In hexadecimal, the transaction is as follows:

Master: 04 30 30 31 31 02 53 32 32 2E 30 4C 03 32
Instrument:

06

Broadcasts

A particular GID (group identifier) and UID (unit identifier) address is reserved for use in broadcast messages; the tilde character '~', hex 7E, can be used as a wild card in the GID and/or UID to selectively broadcast to all or to specific groups of instruments. In this case, no reply to the write request will be sent by any instrument. The only foolproof method of determining whether the write has succeeded is therefore to read back the parameter from each instrument and verify that it is set correctly. **Broadcast is only recommended for systems where failure to communicate a value due to physical failure of wiring or other equipment will not cause damage to equipment.**

Error Codes held in EE

The special 'EE' mnemonic may be used to give the status of the last communications transaction. It is hex format parameter and the values it may contain are as follows:

- 0: No Error
- 1: Invalid Mnemonic
- 2: Parameter is read only
- 7: Incorrect message
- 8: Limit error

Bisynch Message Latency

The time taken for the Series 2000 instrument to process a message and **start** the transmission of a reply is called the latency. This does not include the time taken to transmit the request or reply.

Parameter read functions for 2000 Series EI-Bisynch take place with a latency of between 2 and 10ms.

Parameter write functions for 2000 Series EI-Bisynch take place with a latency of between 5 and 50ms.

It is possible to artificially increase the latency by setting the 'Comms Delay' parameter in the HA configuration list. This is sometimes required to allow a guaranteed gap between requests and responses, needed by some RS485 adaptors to switch from transmit to receive states.

Message Transmission Time

The time required to transmit a message will depend on the length of the message and the baud rate.

Message transmission time =

$$\frac{\text{Number of bytes in the message} * \text{Number of bits per character}}{\text{Baud rate}}$$

The number of bytes in a message can be determined by reference to the information given above.

The number of bits per character will be ten. (1 start bit, 7 data bits, an even parity bit and 1 stop bit).

TROUBLE SHOOTING

USING EI BISYNCH

- Incorrect wiring or faulty hardware (Cable, PC, RS422/485 adaptor, Instrument Comms Module)
- Instrument Address set wrong (PC, Instrument)
- Wrong Line setup, should be 7 data bits, even parity, 1 stop (PC)
- Baud rate set wrongly (PC, Instrument)
- Parity error detected by instrument (Suspect line noise)
- Incorrect message format (PC)