

TCO-100 SERIAL PROTOCOL SPECIFICATION

document version 1.0

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Introduction

Serial communication with the TCO-100 is accomplished by the exchange of messages. A command message is sent to the TCO-100 from the user application. A response message is returned to the user application from the TCO-100. A response message will consist of a single response for query-type messages or multiple responses on some specified interval for mode-type messages.

A message will be defined as a group of bytes consisting of a header, ID, data size, and data. The message header is used by both the TCO-100 and the user application to identify the message and message type. A message header consists of the hexadecimal byte sequence 0xFF 0xEA (255 234). A message ID will be one byte from the list of messages which the TCO-100 recognizes.

In this document all numbers are in decimal notation except for those preceded by '0x'. Such numbers are in hexadecimal notation.

Command messages - to the TCO-100 from the user application

The format for transmitting command messages to the TCO-100 is as follows:

<msg header><msg id>[<data bytes.....>]<checksum>

The data portion of a command message will vary depending on the type of message being sent. Some messages do not require any data to be transmitted so none should be sent. The TCO-100 knows the required number of data bytes for each command message. If a command message is transmitted without the appropriate number of data bytes it will be rejected.

A checksum is required for all messages sent to the TCO-100. The checksum is calculated by exclusive-or'ing together the message id and all data bytes. The message header sequence (0xFF 0xEA) is not included in the checksum calculation. For command messages that contain no data bytes the message ID is sent (again) as the checksum.

Response messages - from the TCO-100 to the user application

The format for the response messages from the TCO-100 is as follows:

<msg header><msg id><data size><data bytes...><checksum>

The message ID indicates to which command message the response is directed. The data size specifies the number of response data bytes forthcoming, including the checksum. All response messages contain at least one data byte.

Query-type messages

These messages return a one-time response.

Mode-type message

Mode-type messages are enabled and disabled. When enabled they output on a given interval, usually once per second at the valid start of the second. All mode-type messages have an option to make a one-time "polled" request for the data, that is, to act like a query message. Some mode-type messages have an optional parameter to request a one-time response.

Configuration-type messages

These messages cause the TCO-100 to alter operation in some way. These messages do not respond.

Firmware version notes

If your firmware version is not current some messages may not be supported. The 'Firmware' section for each message will indicate if that message has been added since firmware version 1.1. All user applications should send message ID 32 to verify that TCO-100 firmware version supports message(s) that the user application requires.

Physical connections to the TCO-100

The TCO-100 has the following I/O connections for RS-232 communications on the rear DB-9 connector labeled *CONTROL OUTPUT*:

- pin 2 - transmit (TX)
- pin 3 - receive (RX)
- pin 5 - ground

For communications with the TCO-100 from an IBM PC/compatible computer a standard null-modem cable may be used. For communications with other types of hosts please observe the following requirements:

- All communications with the TCO-100 are at 9600 baud, 8 data bits, 1 stop bit, no parity.
- Connect the transmit (TX) line of the TCO-100 to the receive (RX) line of the host system.
- Connect the receive (RX) line of the TCO-100 to the transmit (TX) line of the host system.
- Connect the ground of the TCO-100 to the ground of the host system.
- Be sure the host system is capable of communicating by standard RS-232 at 9600 baud, 8 data bits, 1 stop bit, no parity. The TCO-100 can not decode TTL-level serial communications at the DB-9 connector.
- Be sure that any cable you are using for communication with the TCO-100 is within RS-232 standard length and is a working cable. Check the cable connections with an ohmmeter if necessary.

RS-232 Configuration vs. DIP Switch Configuration

The TCO100 time zone and daylight savings time parameters can be configured by on-board dip switches or by RS-232 communication (messages 16 & 17).

The TCO100 will operate with the last applied time zone and daylight savings time parameters it has been provided with. Any change to the dip switches is considered a re-application of the dip switch parameters for the respective function. A configuration change provided via RS-232 is considered an "override" of the DIP switch parameters. The RS-232 configuration for time zone and daylight savings time will then remain in effect until dip switches are changed.

Time zone and daylight savings time configuration are stored in a battery backed-up non-volatile RAM and will survive a power cycle.

The TCO100 leaves the factory configured with no time zone offset or daylight savings time adjustment programmed.

Name: Time Code Generator Time
ID: 0
Type: Mode
Firmware: 1.1

Description: Transmits time code generator time (UTC and local) at 1Hz on-time mark for time code generator.

Notes: This message can be transmitted only when time code generator is active.

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x00	command ID
4	0x??	function (0=disable mode, 1=enable mode, 2=one-time request)
5	0x??	checksum

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x00	response ID
4	0x0F	response data size
5	0x??	UTC hour
6	0x??	UTC minute
7	0x??	UTC second
8	0x??	UTC month
9	0x??	UTC day of month
10	0x??	UTC year (LSB)
11	0x??	UTC year (MSB)
12	0x??	local hour
13	0x??	local minute
14	0x??	local second
15	0x??	local month
16	0x??	local day of month
17	0x??	local day of year (LSB)
18	0x??	local day of year (MSB)
19	0x??	local year (LSB)
20	0x??	local year (MSB)
21	0x??	checksum

Name: GPS-200/200A Status Information
ID: 1
Type: Mode
Firmware: 1.1

Description: Transmits GPS-200/200A receiver status information at 1Hz reference marker (always available).

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x01	command ID
4	0x??	function (0=disable mode, 1=enable mode, 2=one-time request)
5	0x??	checksum

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x01	response ID
4	0x04	response data size
5	0x??	GPS-200/200A availability (0=not connected, 1=connected & communicating)
6	0x??	Position fix quality. Possible position fix quality indications are: 0 = fix not available 1 = non-differential 2 = differential
7	0x??	Position fix type. Possible position fix indications are: 1 = not available 2 = 2-D 3 = 3-D
8	0x??	checksum

Name: TCO-100 Operation Status
 ID: 2
 Type: Mode
 Firmware: 1.1

Description: Transmits a variety of operation status flags at 1Hz reference marker (always available)

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x02	command ID
4	0x??	function (0=disable mode, 1=enable mode, 2=one-time request)
5	0x??	checksum

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x02	response ID
4	0x03	response data size
5	0x??	TCO-100 operation status bits. A bit set indicates the given condition is on/true/active: bit 0 = time code generator bit 1 = daylight/standard time change pending (1-minute advance warning) bit 2 = daylight time applied to generate time bit 3 = <i>reserved</i> bit 4 = <i>reserved</i> bit 5 = <i>reserved</i> bit 6 = last reset cause (1=power-on, 0=other source) bit 7 = stack waterline warning
6	0x??	Time code type. Possible time code type indications are: 0 = SMPTE (30 frames/second, non-drop frame) 1 = SMPTE (25 frames/second) 2 = SMPTE (24 frames/second) 3 = IRIG-B/B(1)
7	0x??	checksum

Name: Time Code Generator Synchronization
ID: 3
Type: Mode
Firmware: 1.1

Description: Transmits time code generator synchronization details at the 1Hz on-time mark for time code generator.

Notes: This message can be transmitted only when time code generator is active.

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x03	command ID
4	0x??	function (0=disable mode, 1=enable mode, 2=one-time request)
5	0x??	checksum

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x03	response ID
4	0x05	response data size
5	0x??	generator 1Hz on-time mark position relative to reference (LSB) ¹
6	0x??	generator 1Hz on-time mark position relative to reference ¹
7	0x??	generator 1Hz on-time mark position relative to reference (MSB) ¹
8	0x00	system reference, one of: 0 = none (free-run) 1 = precision real-time clock 2 = 10mHz oscillator (only available when option installed) 3 = GPS-200/200A
9	0x??	checksum

¹This value is a signed 24-bit number represented in microseconds (µs)

Name:	Set TCO-100 Time Zone Configuration
ID:	16
Type:	Configuration
Firmware:	1.1

Description Configure time zone information the TCO-100 applies to UTC time to derive generate (local) time.

Notes: A take is performed on the new time zone configuration at the next pulse-per-second event. This message may be transmitted only when the TCO-100 is configured to accept RS-232 configuration changes (dip switch SW1-8). The TCO-100 uses the following formula to determine local time: UTC + bias = local time.

A time zone configuration change will be retained in non-volatile RAM and will be maintained over a power cycle. The time zone configuration is changed when re-programmed through RS-232 or by changing any of the time-zone related dip switches.

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x10	command ID
4	0x??	local time bias (in seconds) (LSB) ¹
5	0x??	local time bias (in seconds) ¹
6	0x??	local time bias (in seconds) (MSB) ¹
7	0x??	hour offset ²
8	0x??	half-hour flag (1=on, 0=off) ³
9	0x??	checksum

¹The local time bias value is a signed 24-bit word transmitted as its three 8-bit components.

²The hour offset is an unsigned absolute value representing the hour offset. This value is not used as part of the time zone calculation. Instead, it is used specifically for reporting in the IEEE 1344 extension for IRIG-B. Given the granularity of the time zone bias that is programmable through this message, the setting for this value may depend upon the application. The direction (+/-) of the hour offset will be determined relative to the direction of the bias.

³The half-hour flag is another value that is specifically provided for in the IEEE 1344 extension. Given the granularity of the time zone bias that is programmable through this message, the setting for this flag may depend upon the application.

Name: Set TCO-100 Daylight Savings Time Configuration
ID: 17
Type: Configuration
Firmware: 1.1

Description Configure the daylight savings time window and bias that the TCO-100 applies to local time for time code generation.

Notes: A take is performed on the new configuration at the next pulse-per-second event. This message may be transmitted only when the TCO-100 is configured to accept RS-232 configuration changes. This message can accommodate a greater variety of daylight savings time configurations than can the on-board switch bank selections. Specifying a new daylight savings time configuration does not disable or alter the active time zone configuration.

A daylight savings time configuration change will be retained in non-volatile RAM and will be maintained over a power cycle. The daylight savings time configuration is changed when re-programmed through RS-232 or by changing the daylight savings time dip switch.

Daylight time encoding
When 'dyltype' is set to 0 daylight savings time encoding is disabled and the system assumes that 'stdtype' is also set to 0.

When 'dsttype' is set to 1-5 daylight saving time begins on the...

- 1 = first week
- 2 = second week
- 3 = third week
- 4 = fourth week
- 5 = last week

...of the month specified in 'dstmon' and the day of the week specified in 'dstday' for the current year and at the time specified in 'dsthr/dstmin/dstsec'. Day of week is encoded as (0=Sunday, etc.)

When 'dsttype' is set to 0 daylight savings time begins on an absolute time/date for the current year. 'dstmon' specifies start month, 'dstday' specifies start day of month and 'dsthr/dstmin/dstsec' specifies start time.

Standard time encoding
Encoded exactly as 'Daylight time' with the following exceptions:

- uses standard ... command message members
- indicates when standard time begins (daylight time ends)

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x11	command ID
4	0x??	daylight time bias in seconds (LSB) ¹
5	0x??	daylight time bias in seconds ¹
6	0x??	daylight time bias in seconds (MSB) ¹
7	0x??	daylight encoding type
8	0x??	daylight month
9	0x??	daylight day
10	0x??	daylight hour
11	0x??	daylight minute
12	0x??	daylight second
13	0x??	standard encoding type
14	0x??	standard month
15	0x??	standard day
16	0x??	standard hour
17	0x??	standard minute
18	0x??	standard second
19	0x??	checksum

¹The daylight bias value is a signed 24-bit word transmitted as its three 8-bit components.

Name: Set TCO-100 Time
 ID: 18
 Type: Configuration
 Firmware: 1.1

Description Sets the base (or UTC/GMT) time/date on the TCO-100.

Notes: Time is updated immediately upon receipt of this packet and the time code generator (if active) will be jammed. Time code generation will begin at the beginning of the next second.

The TCO-100 internally maintains a base time that is considered to be UTC/GMT for the purposes of time zone/daylight savings time configuration. Any time zone or daylight savings time configurations will be applied to this base time.

Time set with this function will be overridden if the TCO-100 is connected to the Masterclock, Inc. GPS-200/200A master clock system.

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x12	command ID
4	0x??	hour
5	0x??	minute
6	0x??	second
7	0x??	month
8	0x??	day
9	0x??	year (LSB)
10	0x??	year (MSB)
11	0x??	checksum

Name: TCO-100 product information
 ID: 32
 Type: Query
 Firmware: 1.1

Description: Responds with TCO-100 product information.

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x20	command ID
4	0x20	checksum

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x20	response ID
4	0x08	response data size
5	0x??	TCO-100 firmware version (major)
6	0x??	TCO-100 firmware version (minor)
7	0x??	10mHz precision oscillator option (1=installed, 0=not installed)
8	0x00	SW1 configuration (bit 0 = SW1-1, etc.)
9	0x00	SW2 configuration (bit 0 = SW2-1, etc.)
10	0x00	<i>reserved</i>
11	0x00	<i>reserved</i>
12	0x??	checksum

Name: TCO-100 Time Zone Configuration
 ID: 33
 Type: Query
 Firmware: 1.1

Description: Responds with the current time bias that the TCO-100 applies to UTC time to derive generate (local) time. The TCO-100 uses the following formula to determine local time: UTC + bias = local time.

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x21	command ID
4	0x21	checksum

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x21	response ID
4	0x05	response data size
4	0x??	local time bias (in seconds) (LSB) ¹
5	0x??	local time bias (in seconds) ¹
6	0x??	local time bias (in seconds) (MSB) ¹
7	0x??	checksum

¹The local time bias value is a signed 24-bit word transmitted as its three 8-bit components.

Name: TCO-100 Daylight Savings Time Configuration
ID: 34
Type: Query
Firmware: 1.1

Description: Responds with the current TCO-100 daylight savings time configuration. See configuration message 17 for an explanation of the encoding for values in this packet.

Command format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x22	command ID
4	0x22	checksum

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0x22	response ID
4	0x10	response data size
5	0x??	daylight time bias in seconds (LSB) ¹
6	0x??	daylight time bias in seconds ¹
7	0x??	daylight time bias in seconds (MSB) ¹
8	0x??	daylight encoding type
9	0x??	daylight month
10	0x??	daylight day
11	0x??	daylight hour
12	0x??	daylight minute
13	0x??	daylight second
14	0x??	standard encoding type
15	0x??	standard month
16	0x??	standard day
17	0x??	standard hour
18	0x??	standard minute
19	0x??	standard second
20	0x??	checksum

¹The daylight bias value is a signed 24-bit word transmitted as its three 8-bit components.

Name: Generator Shutdown
 ID: 253
 Type: Diagnostic
 Firmware: 1.0

Description: A packet indicating that the time code generator was shut down. The first date value is always the reason code, followed by variable-length diagnostic data regarding the shutdown.

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0xFE	response ID
4	0x??	response data size
5	0x??	diagnostic code, one of: 01 – jammed due to front-panel time/date update 02 – jammed due to serial time/date update 03 – jammed due to reference/generator time/date discrepancy
...	0x??	???
...	0x??	???
...	0x??	checksum

Name: Diagnostic Code
 ID: 254
 Type: Response-only
 Firmware: 1.0

Description: A variable length packet containing diagnostic information (in-house use only).

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xEA	“ “
3	0xFE	response ID
4	0x??	response data size
5	0x??	diagnostic code
...	0x??	???
...	0x??	???
...	0x??	checksum

Name: Error Messages
ID: 255
Type: Response-only
Firmware: 1.0

Description: Indicates that an RS-232 command message has been rejected. The error code and extended error code fields in the response indicate why the message was rejected.

Response format:

Byte	Value	Description
1	0xFF	message header
2	0xAC	“ “
3	0xFF	response ID
4	0x04	response data size
6	0x??	ID of message which was rejected (if in response to invalid message, otherwise 0xff)
7	0x??	error code ¹
8	0x??	extended error code ²
9	0x??	checksum

¹ Possible error codes are:

- 1 = checksum failure
- 2 = invalid request for current TCO-100 operation mode
- 3 = system-induced reset

² Extended error codes are message dependent. A value of 0 in this field indicates no extended error information is available. See individual message descriptions for potential extended error responses.