**Campbell CR-10X with Stevens GHT**

The following example shows how to program a Campbell CR-10X data logger for serial output on a "C" port to use as input to a Stevens GHT for GOES transmission. The GHT will trigger the CR-10X for data transfer prior to the actual time for a GOES transmission. The CR-10X will send a serial string of data to the GHT, which will be buffered and formatted for transmission. The maximum baud rate of the CR-10X "C" port configured for serial data transfer is 1200 Baud, so the GHT serial port must be set for this baud rate. This is the communications baud rate for the serial port, and does not affect the transmission rate for the GOES transmission (100 or 300 baud).

The pertinent code information is designated P15, below (programming step 11). Also attached are copies of the relevant pages from the Campbell CR-10X programming manual.

**Code Example for use of Stevens GHT with Campbell CR-10X**

```
1:  Volt (SE) (P1)
 1: 1        Reps
 2: 25       2500 mV 60 Hz Rejection Range
 3: 01       SE Channel
 4: 1        Loc [ Test1     ]
 5: 1.0      Mult
 6: 0.0      Offset

2:  Volt (SE) (P1)
 1: 1        Reps
 2: 25       2500 mV 60 Hz Rejection Range
 3: 02       SE Channel
 4: 2        Loc [ Test2     ]
 5: 1.0      Mult
 6: 0.0      Offset


3:  Batt Voltage (P10)
 1: 3        Loc [ Test3     ]

4:  Z=Z+1 (P32)
 1: 4        Z Loc [ Test4     ]

5:  Do (P86)
 1: 10       Set Output Flag High (Flag 0)

6:  Real Time (P77)
 1: 0010     Hour/Minute (midnight = 0000)

7:  Sample (P70)
 1: 1        Reps
 2: 1        Loc [ Test1     ]

8:  Sample (P70)
 1: 1        Reps
 2: 2        Loc [ Test2     ]

9:  Sample (P70)
 1: 1        Reps
 2: 3        Loc [ Test3     ]

10:  Sample (P70)
 1: 1        Reps
 2: 4        Loc [ Test4     ]

11:  Port Serial I/O (P15)
 1: 1        Reps
 2: 1        8-Bit, RS-232 ASCII, 1200 Baud
 3: 150      Delay (0.01 sec units) before TX
 4: 6        C6 RTS/DTR
 5: 1        Start Loc for TX [ Test1     ]
 6: 4     -- Number of Locs to TX
 7: 0000     Termination Character for RX
 8: 0000     Max Characters to RX
 9: 100      Time Out for CTS (TX) and/or RX (0.01 sec units)
10: 6        Start Loc for RX [ _________ ]
11: 1.0      Mult for RX
12: 0.0      Offset for RX
```

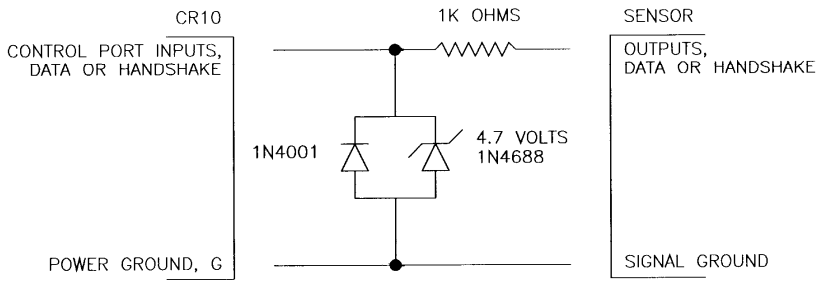


**FIGURE B-1. Circuit To Limit Input to 0 to 5 Volts**

## B.3 INSTRUCTION 15 AND PARAMETER DESCRIPTIONS

| PAR. NO. | DATA TYPE | DESCRIPTION |
|---|---|---|
| 01: | 2 | Repetitions |
| 02: | 2 | Configuration code (xy)<br>First Digit (x)<br>0y ASCII<br>1y ASCII Hex pair<br>2y Binary<br>Second Digit (y)<br>x0 TTL, 1200 baud<br>x1 RS-232, 1200 baud<br>x2 TTL, 300 baud<br>x3 RS-232, 300 baud |
| 03: | 4 | CTS / Delay before send<br>0 = Wait for Clear to Send<br>>0 = delay (.01 secs) |
| 04: 25 | | Control ports RTS/DTR, TXD/RXD |
| 05: | 4 | Output start Loc |
| 06: | 4 | Number of locations to send<br>0 = send nothing<br>xxxx = locations; preamble<br>xxxx-- = locations; data |
| 07: | 4 | Input termination character (0..255) |
| 08: | 4 | Maximum number of input characters |
| 09: | 4 | Time out for CTS and/or Input (.01 secs) |
| 10: | 4 | Input start location |
| 11: | FP | Multiplier |
| 12: | FP | Offset |

INPUT LOCATIONS ALTERED determined by input

INTERMEDIATE LOCATIONS USED preamble size/4 + 1

*EXECUTION TIME*

If Parameters 3 and 6 are zero (0), maximum execution time is Parameter 9 times 0.01 seconds (input time out).

If Parameter 3 is 0 and 6 is not 0, maximum time is Parameter 9 times 0.01 secs times 2 (CTS and input time outs).

If Parameter 8 is 0 (no input), maximum time is Parameter 3 times .01 secs, or Parameter 9 times .01 secs if Parameter 3 = 0.

Add 8.34 msec per byte output (1200 baud).

**NOTE**: Times are shorter if CTS and/or data input is done before Parameter 9 time out.

### PARAMETER 1 - REPETITIONS

Parameter 1 specifies the number of sensors that can be read using the same Instruction 15 parameter configuration. For example, a REP of 3 is used for 3 identical sensors or 3 sensors that are satisfied by the same parameter configuration. Instruction 15 must be entered separately for each sensor or group of sensors requiring a different configuration.

The CR10X sequentially increments sets of control ports and input locations with each repetition. The number of control ports used for each repetition (2, 3 or 4) depends on whether data is to be output and/or input, and the number of lines used to control the timing (Refer to Section B4, "Control Port Configurations and Sensor Wiring").

The starting output location specified in Parameter 5 is used for all repetitions.

## PARAMETER 2 - CONFIGURATION CODE

The configuration code is a two digit number specifying the input format, logic level, baud rate, and optional decimal delimiter.

*ASCII*

This option causes the CR10X to receive and decode an ASCII string of numbers into one or more data values. Data are assumed to consist of an optional sign ("+" or "-") followed by digits and an optional decimal point. Any other character that is not the termination character (Parameter 7) is assumed to be a delimiter between data values; however, the decimal point itself can be configured as a delimiter by a 6X or 7X configuration code enabling user to read higher resolution sensor data. Any digits before a "+" or "-" are discarded. The data is input assuming 1 start bit, 8 data bits, no parity and 1 stop bit, with the 8th (parity) bit ignored. All 8 bits are checked for the terminator character (Parameter 7).

Example: The input string

"-123.456,+1000,0000,2333,.0001*"

is converted to

-123.456, 1000.0, 0.0, 2333.0 and 0.0001

and placed in input locations starting at the location specified in Parameter 10. The termination character is "*" (ASCII equivalent 42).

Scientific notation is not valid. The string "+1.23E-12" is converted into two numbers: 1.23 and -12.0. The "E" is interpreted as a data point delimiter.

*Hexadecimal Pairs in ASCII Representation*

This option decodes ASCII representation of hexadecimal code into decimal values. The value from each pair is stored in separate input locations starting with the location specified in Parameter 10. The data is input assuming 1 start bit, 8 data bits, no parity and 1 stop bit, with the 8th (parity) bit ignored. All 8 bits are checked for the terminator character (Parameter 7).

Example: The input string

"7F7E0A0B0C1E<cr><lf>"

is translated into

127, 126, 10, 11, 12, 30.

The pair "7F" is equal to 7*16+15 = 112 + 15 = 127. Any character with a decimal value below 48 (ASCII character 0) terminates the string. <cr> terminates the string in this example.

*Binary to Decimal Equivalent*

This option receives and converts each 8 bit byte to its decimal equivalent (0-255). The data is input assuming 8 data bits, no parity and 1 stop bit.

Example: The ASCII input string

"7F7E0A0B0C1E<cr><lf>"

is translated into

55, 70, 55, 69, 48, 65, 48, 66, 48, 67, 49, 69, 13, 10

and stored in successive input locations. Note this is the only option that does not discard the 8th (parity) bit.

*RS-232 LOGIC*

The second digit of Parameter 2 can be 0, 1, 3, 5 or 7 to receive RS-232 input. Logical 1 is low voltage and logic 0 is high voltage. Voltage input to the CR10X control ports must not exceed 0 to +5 volts.

*TTL LOGIC*

The second digit of Parameter 2 can be set to 0 1, 2, 4 or 6 to receive TTL input. Logical 1 is high voltage and logic 0 is low voltage.

## PARAMETER 3 - CTS / DELAY BEFORE SEND

If Parameter 3 is zero (0), the CR10X waits for the Clear To Send to come high before sending output. If Clear To Send does not come high within the time specified in Parameter 9, output does not occur and -99999 is placed in the Input Memory Location specified in Parameter 10.

If Parameter 3 is non-zero, this parameter specifies the length of a delay in units of 0.01 seconds between asserting Request To Send and sending output. A CTS line is not used.

## PARAMETER 4 – PORT CONFIGURATION

With single digit codes, Parameter 4 specifies the control port used by the first repetition. The first control port is the RTS/DTR line.

A two-digit parameter (AB) indicates the control ports that will be used by the first repetition (A+1

and/or B+1 may also be used depending on the P15 CONFIGURATION selected). The user can choose any control port for hardware flow control (RTS/DTR) or TXD/RXD provided that any A+1 and B+1 ports required for the P15 CONFIGURATION specified are available.

For double-digit codes (supported starting with OS10X version 1.0014), the first digit specifies the TXD or RXD line and the second digit specifies the RTS/DTR line used by the first repetition. The second digit can be a "0" resulting in no RTS/DTR line. A "0" in the first digit is equivalent to a single digit code. More information on the control ports is given in the Section B4, "Control Port Configuration and Sensor Wiring".

**PARAMETER 5 - OUTPUT START LOCATION**

Parameter 5 specifies the first input location containing data to be sent, if any.

**PARAMETER 6 - NUMBER OF LOCATIONS TO SEND; PREAMBLE OR DATA**

Parameter 6 specifies the number of input locations to send. A "--" following the number indicates that the datalogger needs to convert the values to ASCII. Entering only the number of input locations (i.e., no "--") implies that the values are in ASCII decimal equivalent code.

A "0" in Parameter 6 means send nothing.

If outputting a preamble or command characters to a sensor, the characters must be in the ASCII decimal equivalent code (Appendix E). The preamble is stored in sequential input locations with one ASCII decimal equivalent code (0 to 127) in each location. The CR10X sends the preamble one ASCII character per input location. The decimal codes may be loaded into input locations using Instruction 30. Any negative value indicates that a "BREAK" should be sent. A "BREAK" is a spacing condition of more than 150 milliseconds.

If the number of locations to send is followed by "--", the CR10X sends an ASCII representation of the value in the input location. Seven ASCII characters are sent for each input location

(+ or -, five digits, and a decimal point). This feature is used most often when outputting data to another CR10X. Data points are separated by a space, and the string is terminated with a Carriage Return and Line Feed.

The data are transmitted with 1 start bit, 8 data bits, no parity, and one stop bit. For sensors requiring 7 data bits with 2 stop bits, add 128 to the last input location.

**PARAMETER 7 - INPUT TERMINATION CHARACTER**

The termination character is used to mark the end of the ASCII string received by the CR10X. Regardless of the configuration code, all 8 bits are used in determining the termination character. Thus, if the sensor is sending parity, it may be necessary to add 128 to the decimal value of the character.

If the termination character IS NOT encountered, input will continue until time out (Parameter 9) or until the maximum number of characters (Parameter 8) is received.

Characters received following the termination character are discarded.

**PARAMETER 8 - MAXIMUM NUMBER OF CHARACTERS TO RECEIVE**

Parameter 8 defines the total number of characters to expect per input, including numeric, non-numeric, polarity, decimal, space, and carriage return characters. When the number of characters specified have been received, any additional characters are discarded as if the termination character had been received.

Parameter 8 should be 0 if no input is expected.

**PARAMETER 9 - TIME OUT FOR CLEAR-TO-SEND OR SERIAL INPUT**

Parameter 9 is a 4 digit number that specifies a time out delay in units of 0.01 seconds. The time out specifies one of the following:

- The amount of time to wait for the CTS port to come high (Parameter 3=0 and Parameter 6>0). If the delay lapses, -99999 is stored in the input location specified by Parameter 10 and no data is output. LoggerNet displays an "-INF."

- The amount of time to wait for serial input (Parameter 8>0). If the delay lapses and some characters have been received, it acts like a termination character. If no

characters have been received, a -99999 is stored to indicate a fault in communication.

- Both of the above (Parameter 3=0 and Parameter 6>0 and Parameter 8>0).

If output and input are completed before the end of the delay, program execution immediately advances to the next instruction. Thus, the delay may be over-estimated without slowing down table execution.

If the delay expires, CR10X execution passes on to the next instruction.

The maximum delay is 99.99 seconds. If a longer delay is required, enter –1 for Parameter 9. Under this condition, the program execution passes to the next instruction when one of the other completion conditions (Parameters 7 or 8) are met. Consideration should be given to the power supply and current drain (13 mA) when Instruction 15 is delayed for an extended period.

#### PARAMETER 10 - INPUT LOCATION

This parameter defines the location in the CR10X's Input Storage where the first received data value is stored. Multiple data values are stored in sequential input locations, starting with the one specified by Parameter 10.

#### PARAMETERS 11 AND 12 - MULTIPLIER AND OFFSET

The data received by the CR10X can be scaled using the multiplier and offset parameters. A multiplier of 1 and offset of 0 is required to preserve the data in the same form that it was received.

## B.4 CONTROL PORT CONFIGURATIONS AND SENSOR WIRING

The table below lists all possible input/output configurations.

#### CONFIGURATION 1

Serial data are received by the CR10X. No data or preamble is output; the CTS line is not used. Parameter 6 must be 0 and Parameter 8 must be greater than zero. A single-digit Parameter 4 specifies the control port used for the RTS/DTR line while the next port connects to the Serial Input line. With a double-digit Parameter 4, the first digit specifies the Serial Input line and the second digit, the RTS/DTR line ("0" specifies no RTS/DTR line). With RTS/DTR a total of 2 control ports are used per repetition.

#### CONFIGURATION 2

Serial data are output from the CR10X without using the CTS line. There is no input. Parameters 3 and 6 must be greater than zero and Parameter 8 must be zero. A single-digit Parameter 4 specifies the control port used for the RTS/DTR line while the next port connects to the Serial Output line. With a double-digit Parameter 4, the first digit specifies the Serial Output line and the second digit, the RTS/DTR line ("0" specifies no RTS/DTR line). With RTS/DTR a total of 2 control ports are used per repetition.

#### CONFIGURATION 3

Serial data are output from the CR10X with the aid of the CTS line. There is no input. Parameters 3 and 8 must be zero and Parameter 6 must be greater than zero. A single-digit Parameter 4 specifies the control port used for the RTS/DTR line while the next port connects to the Serial Output line. With a double-digit Parameter 4, the first digit specifies the Serial Output line and the second digit the consecutive CTS and RTS/DTR lines. A total of 3 control ports are used per repetition.

#### CONFIGURATION 4

Serial data are output and serial data received by the CR10X. The CTS line is not used. Parameters 3, 6 and 8 must be greater than zero. A single-digit Parameter 4 specifies the control port used for the RTS/DTR line while the next two consecutive ports connect to the Serial Output and Serial Input lines. With a double-digit Parameter 4, the first digit specifies the consecutive Serial Output and Serial Input lines and the second digit, the RTS/DTR line ("0" specifies no RTS/DTR line). With RTS/DTR a total of 3 control ports are used per repetition.

TABLE B-1. Input/Output Configurations

| # | Configuration | Parameters | | | Port Functions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Single-digit Parameter 4 (**C**) | | | | Qty Ports Used | Double-digit Parameter 4 (**AB**) | | | |
| | | 3 | 6 | 8 | RTS/DTR | CTS | TX | RX | | RTS/DTR | CTS | TX | RX |
| 1 | DTR,RX | x | 0 | nz | C | nc | nc | C+1 | 2 | B | nc | nc | A |
| 2 | DTR,TX | nz | nz | 0 | C | nc | C+1 | nc | 2 | B | nc | A | nc |
| 3 | DTR,CTS,TX | 0 | nz | 0 | C | C+1 | C+2 | nc | 3 | B | B+1 | A | nc |
| 4 | DTR,TX, RX | nz | nz | nz | C | nc | C+1 | C+2 | 3 | B | nc | A | A+1 |
| 5 | DTR,CTS,TX,RX | 0 | nz | nz | C | C+1 | C+2 | C+3 | 4 | B | B+1 | A | A+1 |

nz = non-zero number
x = don't care
nc = not connected
C = first control port (single-digit Parameter 4)
A = TX or RX port (double-digit Parameter 4)
B = control port (double-digit Parameter 4)

TX = serial output
RX = serial input
RTS/DTR = Request to Send /Data Terminal Ready
CTS = Clear to Send
Parameter 3 = CTS/Delay before send
Parameter 6 = Number of Locations to Send
Parameter 8 = Maximum number of characters to receive

"C" is incremented for each repetition by the "No. of Ports Used"
"A" and "B" are incremented for each repetition by the number of TX and RX ports used and the number of RTS/DTR and CTS ports used respectively.

**CONFIGURATION 5**

Serial data are output and serial data received by the CR10X. The CTS line is used. Parameter 3 must be zero while Parameters 6 and 8 must be greater than zero. A single-digit Parameter 4 specifies the control port used for the RTS/DTR line, the next port is for CTS, and the third and fourth ports are for Serial Output and Serial Input, respectively. With a double-digit Parameter 4, the first digit specifies the consecutive Serial Output and Serial Input lines and the second digit specifies the consecutive RTS/DTR and CTS lines. A total of 4 control ports are used per repetition.

## B.5 INPUT DATA FILTERS.

P15 supports search filters strings that can be applied to a received data set. It is typically used locate the beginning of the desired data set. Multiple filters can be applied if the data is imbedded in a long string. To implement a filter string follow P15 immediately with either instructions P63 or P68 (both of which are extended parameter instructions). Multiple use of these instructions can be used if the search string is longer than 8 characters. Separate different types of filter strings with a null character (00). Once the first string has been found and the data decoded and loaded into input locations the next sequential string loaded into P63 or P68 (after the 00) will be used for any other incoming data. If the filter string is not found -99999 will be stored in the input location. Once the last string has been found and the data decoded and loaded into input locations, the first string loaded will be used again.

Enter the actual filter/search string by keying the decimal equivalent of the ASCII character (see Appendix E. of the CR10X Operators Manual).

**Example: GPS receiver program**

A common application with P15 is to read in data from a GPS receiver. The GPS receivers