

# **ST-13 ARGOS SATELLITE TRANSMITTER INSTRUCTION MANUAL**

**4/99**

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# ST-13 ARGOS SATELLITE TRANSMITTER

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# ST-13 ARGOS SATELLITE TRANSMITTER

## 1. ARGOS OVERVIEW<sup>1</sup>

Argos is a one-way satellite based location and data collection system dedicated to monitoring and protecting the environment. The Argos system has been operational since 1978. It was established under an agreement between:

- the National Oceanic and Atmospheric Administration (NOAA, USA)
- the National Aeronautics and Space Administration (NASA, USA)
- the French Space Agency (CNES).

Argos is operated and managed by:

- Collecte, Localisation, Satellites (CLS), a CNES subsidiary in Toulouse, France
- Service Argos, Inc., a CLS subsidiary in Landover, near Washington, DC, USA

## 2. SPACE SEGMENT

The Argos receivers are flown on board the National Oceanic and Atmospheric Administration (NOAA) Polar Orbiting Environmental Satellites (POES) at an altitude of 850 km. At least two satellites are operational at any time in polar circular orbits providing full global coverage. Launches are scheduled through 2010.

The satellites receive the Argos messages from user's transmitters (also called Platform Transmitting Terminal (PTT)) and relay them to ground in real time. They also store them on tape recorders and read out ("dump") the messages every time they pass over one of the three main ground stations:

- Wallops Island, Virginia, USA
- Fairbanks, Alaska, USA
- Lannion, France.

The POES satellites see the North and South Poles on each orbital revolution. Their orbital planes rotate about the polar axis at the same rate as the Earth about the sun, or one complete revolution per year. Each orbital revolution transects the equatorial plane at fixed local solar times. Therefore, each satellite passes within visibility of any given transmitter at almost the same local time each day. The time taken to complete a revolution around the earth is approximately 102 minutes.

At any given time, each satellite simultaneously "sees" all transmitters within an approximate 5000-kilometer-diameter "footprint", or visibility circle. As the satellite proceeds in orbit, the visibility circle sweeps a 5000 kilometer swath around the Earth, covering both poles.

Due to the Earth's rotation, the swath shifts 25° west (2800 km at the Equator) about the polar axis on each revolution. This results in overlap between successive swaths. Since overlap increases with latitude, the number of daily passes over a transmitter also increases with latitude. At the poles, the satellites see each transmitter on every pass, a total of roughly 28 times a day for two satellites (see table 1).

The duration of transmitter visibility by the satellite (or of the pass duration over the transmitter) is the "window" during which the satellite can receive messages from the transmitter. It lasts up to 14 minutes (10 minutes on average).

---

<sup>1</sup> From Argos User Manual 1.0 January 1996

TABLE 1. Station Latitude vs. Number of Argos Satellite Passes

PTT Latitude	Cumulative Visibility Over 24 Hours	Minimum Number Of Passes Per 24 Hours	Mean Number Of Passes Per 24 Hours	Maximum Number Of Passes Per 24 Hours
0 degree	80 min.	6	7	8
± 15 degrees	88 min.	8	8	9
± 30 degrees	100 min.	8	9	12
± 45 degrees	128 min.	10	11	12
± 55 degrees	170 min.	16	16	18
± 65 degrees	246 min.	21	22	23
± 75 degrees	322 min.	28	28	28
± 90 degrees	384 min.	28	28	28

### 3. USER TRANSMITTERS

A transmitter is any station equipped for transmission via the Argos system. Each transmitter, sometimes called a Platform Transmitter Terminal, or PTT, has an individual identification number.

The main signal characteristics are:

- Transmit uplink frequency 401.650 MHz  $\pm$  4 kHz. This must remain stable, as the Argos location calculation (optional service) is based on measurements of the Doppler effect.
- Repetition period, assigned by Service Argos according to the application; for example data collection transmitter are typically assigned either 90 second or 200 second intervals.
- The transmitter message includes:
  - a preliminary synchronization sequence
  - statement of message length which can be 32 to 256 bits
  - the transmitter id number
  - the sensor data or other message data, 32 to 256 bits
- Each message lasts 360 to 920 milliseconds according to the number of message bits.

### 4. GETTING ONTO THE ARGOS SYSTEM

There is a formal application process to get onto the Argos Satellite System. There is also a charge to use the system as well. Since a radio frequency signal is sent up to the satellite users must contact their national telecommunications authority for authorization to use the Argos Uplink frequency. Users in the United States must apply for an Federal Communications Commission (FCC) license. For further information on ARGOS and the FCC visit the following web sites:

#### FCC Information

The user must submit Application Form 442 and Form 159/159-C to the FCC

To order these forms, call (800) 418-3676 or access their web site:

**FCC Web Site:** <http://www.fcc.gov>

#### ARGOS

**ARGOS Web Site:** <http://www.argosinc.com>

- **For users in eastern North America**

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Suite 10  
1801 McCormick Drive  
Landover, MD 20785  
ph# (301) 925-4411  
fax# (301) 925-8995  
E-mail: [useroffice@argosinc.com](mailto:useroffice@argosinc.com)



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Lynwood, WA 98036  
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Fax: (+1) 206-672-8926  
E-Mail: useroffice@argosinc.com

- **For users in Japan**

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Shinagawa-ku  
Tokyo 141  
Japan  
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Fax: (+81) 3-3779-5783  
E-mail: useroffice@argos.cnes.fr (send via  
Toulouse)

- **For users in Australia or New Zealand**

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E-mail: clsargos@bom.gov.au

- **For users anywhere else in the world**

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France  
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Fax: (+33) (0)5-61-751-014  
E-mail: useroffice@argosinc.cnes.fr

## **5. DATA DELIVERY**

Accessing your data is easy. You can retrieve your results from anywhere in the world by public data networks, often within 20 minutes of transmission. Service Argos currently offers data delivery via email, Telnet session, and dial-in modem. Other delivery services (diskette, tape, printout, etc.) are also available.

## **6. DATALOGGER INTERFACE**

Serial interface firmware has been written in the Datalogger Operating System to Interface to the TELONICS ST-13 ARGOS Transmitter. Current Dataloggers supported are the CR10, CR10X, CR23X, CR500, and CR510 Dataloggers. The CR10 requires a Library Special EPROM to be physically installed. The standard CR10 Firmware does not support communications between the Datalogger and ST-13 Transmitter (P99). The CR10X, CR23X, CR500, and CR510 Dataloggers supports this special instruction in a Flash EPROM (P121) as shipped from the factory.

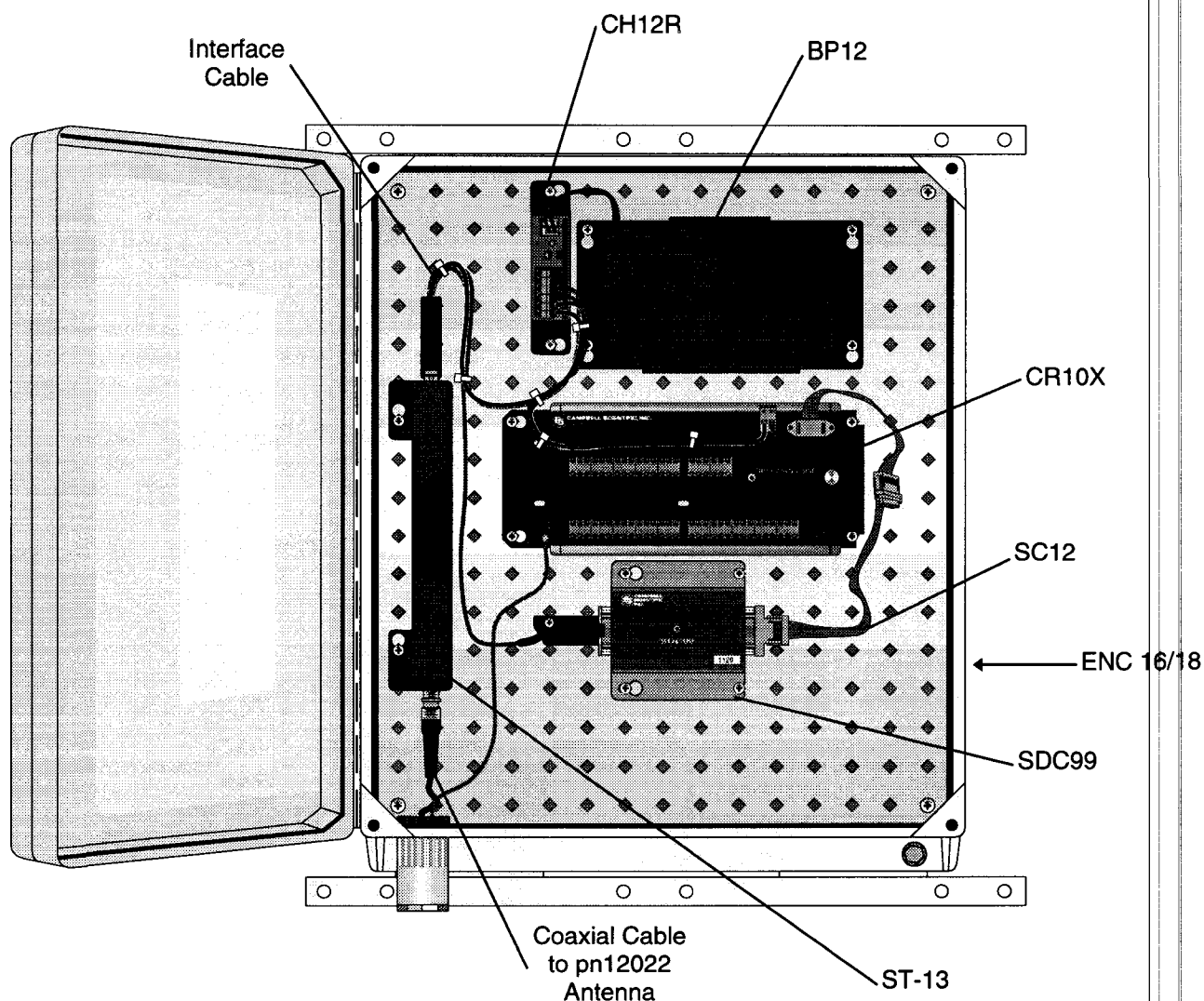
This firmware interface passes commands and data from the Datalogger to the ST-13 Buffer. Only low resolution 2-byte final storage datalogger data is transferred over the Argos Satellite Link. This 16-bit data consists of 4 significant digits, polarity and decimal. The first 3 bits identify the polarity and decimal placement and the remaining 13 bits are the actual data. When the user collects the data, they are required to convert the data back into a decimal value. See Appendix A for information on converting CSI's 2-byte Low Resolution Final Storage Format.

## **7. DATALOGGER TO ST-13 PHYSICAL CONNECTIONS**

Physical connections between the datalogger and ST-13 are handled by a 9-pin serial cable (SC12), SDC99 Synchronous Serial Interface, and a 9 to 25 pin custom serial cable. The SDC99 provides a synchronous interface to allow other synchronous devices such as storage modules and keypads to be connected at the same time. The SDC99 also provides a tri-stated wake up signal to the ST-13 prior to commands being sent from the datalogger. (See Figure 1.)

**Datalogger---BLUE SC12 CABLE---SDC99--  
9 to 25 Pin Custom Interface Cable---ST-13**

## ST-13 ARGOS SATELLITE TRANSMITTER



**FIGURE 1. ST-13 Enclosure Assembly**

### CR10X/SDC99/ST13 Physical Connections

1. Connect the female side of the blue SC12 9-pin serial cable to the SDC99 Interface labeled "DATALOGGER".
2. Connect the other side of the blue SC12 9-pin serial cable to the Datalogger's 9-pin serial port.
3. Connect Satellite Transmitter interface cable (9-25 Pin Cable) 9 pin male connector to the SDC99 Interface labeled "PERIPHERAL".
4. Connect the other side of this cable (25 pin male) to the ST-13 Transmitter's 25 pin female serial port.
5. Connect the Satellite Transmitter interface BLACK power cable to the CH12R's GROUND screw terminal.
6. Connect the Satellite Transmitter interface RED power cable to the CH12R's +12V screw terminal.
7. See Figure 1 for an enclosure assembly view.

## 8. SDC99 MODIFICATION INFORMATION

The SDC99 is used to interface between the Datalogger and ST-13. There is a 4503 Tri-state Buffer on the SDC99 circuit card. Pins 2 and 3 of this Tri-state Buffer are switched at the factory. This modification does not affect the Datalogger Synchronous Addressing Functions. These modifications must be performed at the factory.

The modification permits the Datalogger to use the Hand Shake line to send the "wake-up" to the ST-13. The ST-13 "wake-up" command sequence is performed by driving the ST-13 wake-up line low for 30 ms and then dropping (high impedance) the line.

Open the SDC99 and verify the proper jumper settings.

SDC99 Serial Interface jumper settings

O = OPEN

X = JUMPERED

### SDC99

O  
O  
X  
O  
O  
O  
X  
O

X  
O  
X  
O  
O  
X

## 9. SDC99 TO ST-13 INTERFACE CABLE

This cable is placed between the SDC99 Interface and the ST-13 Transmitter. The ST5 transmitter (now discontinued by Telonics) requires a slightly different pinout as shown below. Pinout of the cable as follows:

9 Pin	ST5 25 Pin	ST-13 25Pin	Description
2	13	25	Data Ground
7	1	1	CR10 Hand Shake line; ST-13 wake-up line
4	2	2	CR10 Receive Data. ST-13 Transmit Data.
9	14	14	CR10 Transmit Data. ST-13 Receive Data.
	12	12	+7 to +11 VDC. *Power for ST-13 (Red Lead).
	11	11	Ground (Black Lead)

*\* The ST-5 requires this range for proper operation. The user should purchase the TSR-1 voltage regulator from TELONICS. This allows the user to provide a +12 to +28 VDC input when the TSR-1 is installed in the ST-5. The ST-13 has the voltage regulator built-in and to date has replaced the older ST-5.*

## 10. INSTRUCTION 121: DATA TRANSFER AND CONTROL COMMAND TO ST-13

Instruction 121 is the ST-13 / Datalogger Firmware Interface (P99 for CR10). It has three two byte parameters. The ST-13 may require up to three binary bytes in its command string followed by data where applicable.

Instruction 121 in the Datalogger outputs these command bytes along with all data in the active final storage area. The value and function of these command bytes are described in the TELONICS ASYNCHRONOUS SERIAL INTERFACE—Appendix A. This interface manual represents the commands as binary values. The binary values must be converted to decimal and this decimal value is entered in Instruction 121.

The processed data values (maxima, minima, etc) are output to the ST-13 in the raw CSI two byte binary format. It is also important to note that the datalogger and ST-13 communicate at only 1200 Baud. If the ST-13 is configured for any other baud rate the software interface will not work.

## ST-13 ARGOS SATELLITE TRANSMITTER

### Data Transfer Command Examples:

Binary Command	Decimal	Function
00010000	16	Send Data to ST-13 but do not transmit.
01110010	114	Automatic repeat RF Transmission command.

Sample CR10X Instruction 121 (see attached programming example for placement and structure).

#### P121 ARGOS Satellite Communication

01:	16	Command Byte #1 (send data to ST-13)
02:	00	Command Byte #2
03:	00	Command Byte #3

#### P121 ARGOS Satellite Communication

01:	114	Command Byte #1 (Begin pre-programmed Automatic Transmission)
02:	00	Command Byte #2
03:	00	Command Byte #3

Since the ST-13 only has a 32 byte buffer, the maximum number of datapoints that can be sent to the satellite per transmission is 16 CSI datapoints (32 bytes / 2 bytes per d.p.). Data is sent from the Datalogger's active final storage area to the ST-13's buffer. Command 16 above assumes that you have allocated 32 bytes in the first ARGOS ID CODE INDEX (1) of the ST-13 buffer. If you allocated it in the last ARGOS ID CODE INDEX (8) the decimal equivalent for

data transfer would be 23. See ST-13 Configuration Report from Telonics on how your unit is configured.

## 11. IMPORTANT OUTPUT ARRAY ID INFORMATION

When sending final storage data to the ST-13, the Array ID is automatically stripped in order to maximize data transfer to the ST-13, however; the Array ID is still maintained in the Datalogger and or Storage Module.

P121 and P99 (CR10) require the Array ID to be set to 99 or less. If your default Array ID is greater than 99, use instruction 80 (P80) to set the ID to 99 or less. P80 should be placed immediately after the setting of the output Flag (0). For further details on P80 please refer to the Datalogger Operator's Manual.

## 12. TRANSMISSION CONSIDERATIONS

ARGOS is a one-way satellite broadcast medium that transfers data from a CR500, CR510, CR10(X), CR23X platform located *anywhere* in the world to a polar orbiting satellite system. The number of passes over a specific geographic location is a function of the users latitude. In general there are about 28 passes per day at the north and south poles and about 8 passes per day at the equator. The satellite is overhead on average for about 10 minutes duration. Most users are assigned either a 200 second transmitter repetition rate or 90 second repetition rate. Table 2 will show the actual number of data points that can be transferred over the Argos satellite link.

**TABLE 2. Station Latitude, Number of Satellite Passes, number of CSI Datapoints that can be transferred per ID code and repetition rate per 24 hour period.**

PTT Latitude	Cumulative Visibility Over 24 Hours	Mean Number Of Passes Per 24 Hours	200 Second Repetition Rate	90 Second Repetition Rate
0 degree	80 min.	7	336 d.p.	672 d.p.
± 15 degrees	88 min.	8	384 d.p.	768 d.p.
± 30 degrees	100 min.	9	432 d.p.	864 d.p.
± 45 degrees	128 min.	11	528 d.p.	1056 d.p.
± 55 degrees	170 min.	16	768 d.p.	1536 d.p.
± 65 degrees	246 min.	22	1056 d.p.	2112 d.p.
± 75 degrees	322 min.	28	1344 d.p.	2688 d.p.
± 90 degrees	384 min.	28	1344 d.p.	2688 d.p.

## 13. DATA INTEGRITY

Since the ARGOS system is currently a one-way broadcast, there is no error checking or retries if the 32 byte data packet gets corrupted in its RF transmission from the ST-13 to the Orbiting Satellite. Since this is the case, transmission redundancy of the same data set is only way to ensure the integrity of the data received by the satellite. Several methods of redundancy of data transmissions are possible. This will result in a reduced number of new data points but does ensure the integrity of the data.

1. Since a maximum of 16 data points can be sent in one transmission, send (2) groups of the same 8 data points.
2. Transmit the same group of 16 data points multiple times.

## 14. PROGRAMMING ALTERNATIVE A

If more than 16 datapoints need to be sent, there is an alternative method. It should be noted that the usual ARGOS method is to repeat the same data transmission to ensure the data was received by the satellite. Since there is no receiver on the ST-13, it does not know whether or not data was received by the satellite, or even if the satellite is overhead. The method of redundant data transmission is the only sure method that a user will get his data.

The ST-13 currently has (2) 32 byte software buffers that will a user to transfer (2) different data sets or the same data set over the satellite link. The method involves placing 16 data points (32 bytes) into buffer 1 and 16 data points (32 bytes) into buffer 2, then alternately transmitting each buffer at the pre-defined interval.

Programming sequence (assuming slot 8 of the ID code index is assigned 32 bytes).

Output Data from first Interval

Transfer Data to  
ST-13 Buffer 1 [P121 Command 16]

Output Data from second Interval

Transfer Data to  
ST-13 Buffer 2 [P121 Command 32]

Configure ST-13 to  
Alternately Transmit  
Buffer 1 and Buffer 2 [P121 Command 118]

The transfer of data to each buffer should also take place in conditional DO statements and after an output has occurred:

EXAMPLE of Conditional DO Statement:

If time is (P92)

1:	0	Minutes (Seconds --) into a
2:	60	Interval (same units as above)
3:	30	Then Do

Data Transfer to ARGOS ST-13 (P121)

1:	16	Command Byte #1
2:	0000	Command Byte #2
3:	0000	Command Byte #3

End (P95)

## 15. PROGRAMMING ALTERNATIVE B

The user should verify whether a sufficient number passes are available, and hence this second method may not be required. Keep in mind that there are more satellite passes at the poles (~24) and fewer at the equator (~8).

What the user needs to do for Alternative B is to re-direct the processed data (averages, maxima, minima) back into a series of input storage locations (floating buffer). Then periodically the data is sampled to final storage where P121 (16) and P121 (114) can be executed.

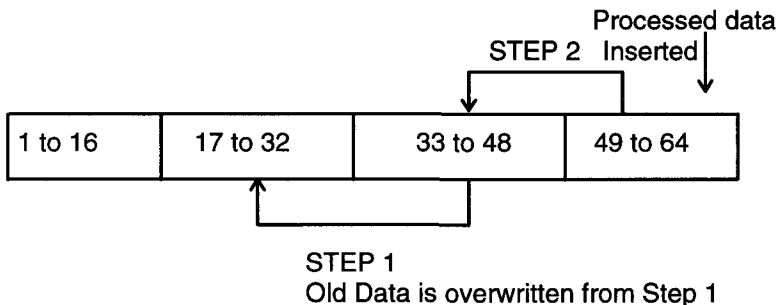
An attached programming example for the CR10(X) that provides the scenario for moving data block of 16 datapoints every 20 minutes, hence at minutes 20, 40 and 60, new data is sent and transmitted at 90 second (optional from ARGOS) intervals.

# ST-13 ARGOS SATELLITE TRANSMITTER

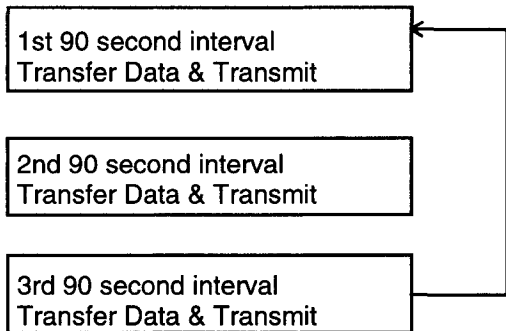
## Theory Block Diagram

### PART A

Input Locations  
STEP 3 New 20 Min.



### Part B Transfer & Transmit



## 16. POWER BUDGET AND POWER SUPPLY CONSIDERATIONS

CSI dataloggers have a very low quiescent current drain (typically 1mA). The Telonics ST-13 transmitter also has a very low quiescent current drain as well (100 uA). The higher source of current drain from these device will come when either the ST-13 is transmitting (550mA) or when the datalogger is making measurements frequent measurements (46 mA). Other sources of current drain should be considered such as devices requiring 12VDC and whether or not their power is being switched on and off.

Since Argos satellite telemetry is often used in very remote areas of the world, proper selection of batteries and solar panels depends on knowing the power budget of the telemetry "system". Below is a power budget example of a "standard" CSI weather station transmitting data every 200 seconds. The datalogger is

making environmental measurements every 30 seconds.

### 16.1 CR10X BASED WEATHER STATION

State	Duration (sec)	Current Drain (mA)
Analog Measurement	0.2	46
Processing	0.03	13
Quiescent	29.77	1

Average Current Drain Calculations:

$$\frac{(0.02s)(46mA) + (0.03s)(13mA) + (29.77s)(1mA)}{30 s} = 1.312mA$$

## 16.2 ST-13 ARGOS TRANSMITTER (200 SECOND TRANSMISSION INTERVALS)

State	Duration (sec)	Current Drain (mA)
Writing Data to ST-13 Buffer	0.300	10
Transmitting Data	0.920	550mA

$$\frac{(0.30s)(10mA) + (0.920s)(550mA) + (198.78s)(0.1mA)}{200s} = 2.64439 \text{ mA}$$

## 16.3 ST-13 ARGOS TRANSMITTER (90 SECOND TRANSMISSION INTERVALS)

$$\frac{(0.30s)(10mA) + (0.920s)(550mA) + (88.78s)(0.1mA)}{90s} = 5.7542 \text{ mA}$$

## 16.4 AVERAGE DAILY SYSTEM CURRENT DRAIN CALCULATION

200 second transmission = 3.95639 mA\*24 hours/day = 94.95336 mA\*hours/day ≈ 0.1Ah/day

90 second transmission = 7.0662 mA\*24 hours/day = 169.5888 mA\*hours/day ≈ 0.2 Ah/day

The power budget assumptions in the above example shows how low the system current drain actually is. Power supply selection and Solar Panel size based off of this example are largely determined by the geographical area of the world and the minimum number of sun hours per day (defined as 1kWh/m2 irradiance) in the wintertime.

High Latitude applications will have to consider the maximum number of days of darkness (i.e.,

~180 days) and use the estimated calculations above to select an appropriate battery.

Given that the locations where these telemetry platforms are typically installed are very remote and costly to get to a safe rule of thumb is to take the estimated number of amp hours and double that value. This will help to take into consideration cold temperatures where the amp-hour capacity of a battery is reduced.

### Battery Selection Example:

180 days x 0.2 Ah/day x 2 = 72 Amp Hours @ 12VDC

### Solar Panel Selection Example:

10 Watt Solar Panel (Model MSX10)

This solar panel will output 0.57 A in full sun. Since the power budget requirement is only 0.2 Ah/day, if the station sees approximately 1 hour of full sun, the station battery should remained fully charged.

## 17. PROGRAMMING EXAMPLES

The first program example below demonstrates a basic weather station application of transferring 16 low resolution data points to the ST-13 buffer. The Datalogger then sends a command to have the ST-13 begin its transmission sequence.

The second program example is an alternative programming method to send more than 16 new data points over the satellite link. This is described in program example B above.

## ST-13 ARGOS SATELLITE TRANSMITTER

### PROGRAM EXAMPLE 1

```
;{CR10X}
;
;Sample CR10X/ST-13 Argos Weather Station Program
;
;Generates 16 hourly datapoints
;
;Hourly Output Array Definitions of Data being sent to ST-13 Buffer
;
;Element #   Description
;
;  1   Julian Date
;  2   Time
;  3   Average Air Temperature: Deg C
;  4   Max Air Temp: Deg C
;  5   Min Air Temp: Deg C
;  6   Sample Relative Humidity: %
;  7   Average Soil Temp #1: Deg C
;  8   Average Soil Temp #2: Deg C
;  9   Mean Wind Speed: m/s
; 10   Mean Wind Vector Magnitude
; 11   Mean Wind Vector Direction: Degrees
; 12   Standard Deviation of Wind Direction: Degrees
; 13   Maximum Wind Speed: m/s
; 14   Average Barometric Pressure: mbars
; 15   Average Solar Radiation: W/m^2
; 16   Sample Battery Voltage: VDC
```

\*Table 1 Program

01:	30	Execution Interval (seconds)
-----	----	------------------------------

; \*\* HMP45C Air Temperature \*\*

1: Do (P86)

1:	41	Set Port 1 High
----	----	-----------------

2: Excitation with Delay (P22)

1:	1	Ex Channel
2:	0	Delay W/Ex (units = 0.01 sec)
3:	15	Delay After Ex (units = 0.01 sec)
4:	0	mV Excitation

3: Volt (SE) (P1)

1:	1	Reps
2:	5	2500 mV Slow Range
3:	1	SE Channel
4:	1	Loc [ Temp_C ]
5:	0.1	Mult
6:	-40.0	Offset

; \*\* HMP45C Relative Humidity \*\*



## 4: Volt (SE) (P1)

1:	1	Reps
2:	5	2500 mV Slow Range
3:	2	SE Channel
4:	2	Loc [ RH_perc ]
5:	0.1	Mult
6:	0.0	Offset

## 5: Do (P86)

1:	51	Set Port 1 Low
----	----	----------------

; \*\* Two 107 Soil Temperature Probes \*\*

## 6: Temp (107) (P11)

1:	2	Reps
2:	3	SE Channel
3:	1	Excite all reps w/E1
4:	3	Loc [ Soil_1 ]
5:	1.0	Mult
6:	0.0	Offset

; \*\* R.M. Young 05103 Wind Speed \*\*

## 7: Pulse (P3)

1:	1	Reps
2:	1	Pulse Channel 1
3:	21	Low Level AC, Output Hz
4:	5	Loc [ Wind_Spd ]
5:	0.0980	Mult
6:	0.0	Offset

; \*\* R.M. Young 05103 Wind Direction \*\*

## 8: Excite-Delay (SE) (P4)

1:	1	Reps
2:	5	2500 mV Slow Range
3:	5	SE Channel
4:	2	Excite all reps w/Exchan 2
5:	2	Delay (units 0.01 sec)
6:	2500	mV Excitation
7:	6	Loc [ Wind_Dir ]
8:	0.142	Mult
9:	0.0	Offset

; \*\* Vaisala Barometric Pressure Model CS105 \*\*

## 9: Do (P86)

1:	42	Set Port 2 High
----	----	-----------------

## 10: Excitation with Delay (P22)

1:	1	Ex Channel
2:	0	Delay W/Ex (units = 0.01 sec)
3:	100	Delay After Ex (units = 0.01 sec)
4:	0	mV Excitation

## ST-13 ARGOS SATELLITE TRANSMITTER

### 11: Volt (SE) (P1)

1:	1	Reps
2:	5	2500 mV Slow Range
3:	6	SE Channel
4:	7	Loc [ Baro_P_mb ]
5:	0.184	Mult
6:	600	Offset

### 12: Do (P86)

1:	52	Set Port 2 Low
----	----	----------------

; \*\* Li-Cor Pyranometer Model LI200X

### 13: Volt (Diff) (P2)

1:	1	Reps
2:	2	7.5 mV Slow Range
3:	4	DIFF Channel
4:	8	Loc [ Solar ]
5:	200	Mult
6:	0.0	Offset

; \*\* CR10X Battery Voltage \*\*

### 14: Batt Voltage (P10)

1:	9	Loc [ Battery ]
----	---	-----------------

; \*\* This section will output 16 low resolution data points \*\*

; \*\* The Array ID is not sent to the transmitter but must be less than 99 \*\*

; \*\* REMEMBER, YOU CAN ONLY TRANSMIT A MAXIMUM OF ONLY 16 LOW  
; RESOLUTION DATA POINTS \*\*

### 15: If time is (P92)

1:	0	Minutes (Seconds --) into a
2:	60	Interval (same units as above)
3:	10	Set Output Flag High (Flag 0)

### 16: Set Active Storage Area (P80)

1:	1	Final Storage Area 1
2:	60	Array ID

; Data Point #'s 1 & 2

### 17: Real Time (P77)

1:	220	Day,Hour/Minute (midnight = 2400)
----	-----	-----------------------------------

; Data Point #3

### 18: Average (P71)

1:	1	Reps
2:	1	Loc [ Temp_C ]

; Data Point #4

## 19: Maximum (P73)

1:	1	Reps
2:	0	Value Only
3:	1	Loc [ Temp_C ]

; Data Point #5

## 20: Minimum (P74)

1:	1	Reps
2:	0	Value Only
3:	1	Loc [ Temp_C ]

; Data Point #6

## 21: Sample (P70)

1:	1	Reps
2:	2	Loc [ RH_perc ]

; Data Point #'s 7 &amp; 8

## 22: Average (P71)

1:	2	Reps
2:	3	Loc [ Soil_1 ]

; Data Point #'s 9-12

## 23: Wind Vector (P69)

1:	1	Reps
2:	0	Samples per Sub-Interval
3:	02	S, U, éu, â(éu) Polar
4:	5	Wind Speed/East Loc [ Wind_Spd ]
5:	6	Wind Direction/North Loc [ Wind_Dir ]

; Data Point #13

## 24: Maximum (P73)

1:	1	Reps
2:	00	Time Option
3:	5	Loc [ Wind_Spd ]

; Data Point #14

## 25: Average (P71)

1:	1	Reps
2:	7	Loc [ Baro_P_mb ]

; Data Point #15

## 26: Average (P71)

1:	1	Reps
2:	8	Loc [ Solar ]

; Data Point #16

## ST-13 ARGOS SATELLITE TRANSMITTER

### 27: Sample (P70)

1:	1	Reps
2:	9	Loc [ Battery ]

; At the beginning of each hour the data will be sent  
; to the ST-13 Buffer and will begin transmitting  
; immediately at 200 second intervals

; The Telonics ST-13 Asynchronous Serial Interface Users's Guide  
; represents commands as binary values. The binary values must be  
; converted to decimal and this decimal value is entered in the Instruction  
; P121 parameter. The data values are output to the ST-13 in the raw CSI  
; two-byte binary format. This data must be converted back to a decimal  
; value when retrieved from Service Argos.

### 28: If time is (P92)

1:	0	Minutes (Seconds --) into a
2:	60	Interval (same units as above)
3:	30	Then Do

; Cancel any Auto-Repeat Transmissions in the ST-13  
; BEFORE writing data to buffer.

### 29: Data Transfer to ARGOS ST-13 (P121)

1:	128	Command Byte #1
2:	0000	Command Byte #2
3:	0000	Command Byte #3

; Transfer 16 CSI low resolution data points to Buffer #1 of  
; ST-13 memory. ID Slot #8 is used in this example.

### 30: Data Transfer to ARGOS ST-13 (P121)

1:	16	Command Byte #1
2:	0000	Command Byte #2
3:	0000	Command Byte #3

; This command will start the transmission of data and transmit  
; it at the default interval of 200 seconds. See Telonics  
; Software report for ST-13 configuration.

### 31: Data Transfer to ARGOS ST-13 (P121)

1:	114	Command Byte #1
2:	0000	Command Byte #2
3:	0000	Command Byte #3

### 32: End (P95)

#### \*Table 2 Program

02:	0.0000	Execution Interval (seconds)
-----	--------	------------------------------

#### \*Table 3 Subroutines

End Program

1	[ Temp_C ]	RW--	3	1	-----
2	[ RH_perc ]	RW--	1	1	-----
3	[ Soil_1 ]	RW--	1	1	Start -----
4	[ Soil_2 ]	RW--	1	1	----- End
5	[ Wind_Spd ]	RW--	2	1	-----
6	[ Wind_Dir ]	RW--	1	1	-----
7	[ Baro_P_mb ]	RW--	1	1	-----
8	[ Solar ]	RW--	1	1	-----
9	[ Battery ]	RW--	1	1	-----

## PROGRAM EXAMPLE 2

```

1;{CR10X}
;
;Alternate programming method to send more than
;16 datapoints over the satellite link.
;
;-----
;PROGRAM EXAMPLE:
;-----
;
;20 minute floating buffer for ST-13/ARGOS system.
;
;CR10 controls 90 second transmission of alternating
;20 minute data. Alternately this can be used to only
;transfer data to the ST-13 and not force a transmission.
;
;-----
;THEORY:
;-----
;PART 1 MOVING 20 MINUTE DATA
;
;Measurements occur in Locations 1-14 (User Defined).
;Every 20 minutes processed data (maxima, minima,
;averages, etc.) + Timestamp (Julian Date, Time) are
;placed back into 16 sequential input locations 49-64.
;
;PRIOR to putting data into these input locations,
;data is shifted in blocks of 16 datapoints:
;
;First:  Data in input locations 33 to 48 are moved
;sequentially to input locations 17 to 32.
;
;Second: Data in input locations 49 to 64 are moved
;sequentially to input locations 33 to 48.
;
;Third:  Newly Processed 20 minute Data is written
;back into input locations 49 to 64.
;

```

---

## ST-13 ARGOS SATELLITE TRANSMITTER

```
;
;PART 2 TRANSFERRING AND TRANSMITTING ALTERNATING
;20 MINUTE DATA EVERY 90 SECONDS
;
```

```
;P26 is used as the 90 second timer and should be placed
;as the very first instruction in the 30 second Table,
;(TABLE 1).
```

```
;
;When the timer = 90 seconds a counter is initiated to 1
;and will increment by 1 every 90 seconds to a maximum
;of 3. (3 representing the (3) 20 minute arrays).
;When the counter = 3 it is zeroed.
```

```
;
;The TIMER is zeroed each timer it equals 90 seconds.
;
```

```
;
;When the counter=1 processed data from input locations
;17 to 32 are sampled and sent to final storage area 2.
;P99 is executed to send data to the ST-13 buffer #1 and
;then it is immediately transmitted.
```

```
;
;90 seconds later the counter = 2 and processed data
;in input locations 33 to 48 are sampled to final
;storage area 2. P99 is executed to send data to the
;ST-13 buffer #1 and then it is immediately transmitted.
```

```
;
;90 seconds later the counter = 3 and processed data
;in input locations 49 to 64 are sampled to final
;storage area 2. P99 is executed to send data to the
;ST5 buffer #1 and then it is immediately transmitted.
```

```
;
;When the COUNTER = 3 it is zeroed, and the counter will
;increment to 1 90 seconds later.
```

```
*Table 1 Program
```

```
01:      30      Execution Interval (seconds)
```

```
;
;** P26 used for 90 second control timer **
```

```
1: Timer (P26)
```

```
1:      63      Loc [ Timer   ]
```

```
;
;** Move a block of 16 Datapoints from locations
;33 to 48 to locations 17 through 32 every 20 minutes
;BEFORE shifting data from locations 49 through 64 to
;33 through 48.
```

```
2: If time is (P92)
```

```
1:      0      Minutes (Seconds --) into a
2:      20      Interval (same units as above)
3:      30      Then Do
```

```
;
;>>> 20 min DATA BLOCK SHIFT #1 <<<
```

```

3: Block Move (P54)
  1:      16      No. of Values
  2:      31      First Source Loc [ BlockB_1 ]
  3:       1      Source Step
  4:      15      First Destination Loc [ BlockA_1 ]
  5:       1      Destination Step
;
;>>> 20 min DATA BLOCK SHIFT #2 <<<
; ** Move a block of 16 datapoints from locations
; from 49 through 64, to 33 through 48.

4: Block Move (P54)
  1:      16      No. of Values
  2:      47      First Source Loc [ BlockC_1 ]
  3:       1      Source Step
  4:      31      First Destination Loc [ BlockB_1 ]
  5:       1      Destination Step
;
; ** P95 End Block Move **

5: End (P95)
;
; ** Output 20 minute processed data **

6: If time is (P92)
  1:       0      Minutes (Seconds --) into a
  2:      20      Interval (same units as above)
  3:      10      Set Output Flag High
;
; ** Send processed data to input locations 49 to 64 **

7: Set Active Storage Area (P80)
  1:       3      Input Storage Area
  2:      47      Array ID or Loc [ BlockC_1 ]
;
; ** Timestamp (Datapoints 1 & 2) **

8: Real Time (P77)
  1:      220      Day,Hour/Minute (midnight = 2400)
;
; ** Processed Data (Datapoints 3 to 16)

9: Average (P71)
  1:      14      Reps
  2:       1      Loc [ Meas__1 ]
;
; ** If the timer = 90 seconds then DO **

10: If (X<=>F) (P89)
  1:      63      X Loc [ Timer   ]
  2:       3      >=
  3:      90      F
  4:      30      Then Do
;
; ** Start Counter **

```

## ST-13 ARGOS SATELLITE TRANSMITTER

```
11: Z=Z+1 (P32)
   1:      64      Z Loc [ Counter ]
   ;
   ;** If counter = 1 then DO **

12: If (X<=>F) (P89)
   1:      64      X Loc [ Counter ]
   2:      1      =
   3:      1      F
   4:      30      Then Do
   ;
   ;** Output Data to Final Storage Area 2 **

13: Set Active Storage Area (P80)
   1:      2      Final Storage Area 2
   2:      1      Array ID or Loc [ Meas__1 ]
   ;
   ;** Set Output Flag HI (10) **

14: Do (P86)
   1:      10      Set Output Flag High
   ;
   ;** Send first 16 datapoints to Final Storage Area 2 **

15: Sample (P70)
   1:      16      Reps
   2:      15      Loc [ BlockA_1 ]
   ;
   ;** Zero 90 second Timer for next Interval *

16: Timer (P26)
   1:      63      Loc [ Timer ]
   ;
   ;** Send 16 datapoints to ST-13 Buffer #1 and Transmit **
   ;
   ;>>> OR USE 16 IN THE FIRST BYTE INSTEAD OF 48 <<<
   ;>>> 23 WILL ONLY DUMP DATA AND NOT TRANSMIT <<<

17: Data Transfer to ARGOS ST-13 (P121)
   1:      48      Command Byte #1
   2:      0000    Command Byte #2
   3:      0000    Command Byte #3
   ;
   ;** P95 End if Counter = 1 **

18: End (P95)
   ;
   ;** If counter = 2 then DO **

19: If (X<=>F) (P89)
   1:      64      X Loc [ Counter ]
   2:      1      =
   3:      2      F
   4:      30      Then Do
   ;
```



```
;** Output Data to Final Storage Area 2 **
```

```
20: Set Active Storage Area (P80)
```

```
1:      2      Final Storage Area 2
2:      2      Array ID or Loc [ Meas__2 ]
```

```
21: Do (P86)
```

```
1:      10      Set Output Flag High
```

```
;** Output Next 16 Datapoints **
```

```
22: Sample (P70)
```

```
1:      16      Reps
2:      31      Loc [ BlockB_1 ]
```

```
** Zero 90 second Timer for next interval **
```

```
23: Timer (P26)
```

```
1:      63      Loc [ Timer ]
```

```
** Send 16 datapoints to ST5 Buffer #1 and Transmit **
```

```
;>>> OR USE 16 INSTEAD OF 48 IN THE FIRST BYTE <<<
```

```
;>>> 16 WILL ONLY DUMP DATA AND NOT TRANSMIT <<<
```

```
24: Data Transfer to ARGOS ST-13 (P121)
```

```
1:      48      Command Byte #1
2:      0000     Command Byte #2
3:      0000     Command Byte #3
```

```
** P95 End if counter = 2 **
```

```
25: End (P95)
```

```
** If counter = 3 then DO **
```

```
26: If (X<=>F) (P89)
```

```
1:      64      X Loc [ Counter ]
2:      1      =
3:      3      F
4:      30      Then Do
```

```
** Output Data to Final Storage Area 2 **
```

```
27: Set Active Storage Area (P80)
```

```
1:      2      Final Storage Area 2
2:      3      Array ID or Loc [ Meas__3 ]
```

```
28: Do (P86)
```

```
1:      10      Set Output Flag High
```

```
** Output 16 Datapoints **
```

```
29: Sample (P70)
```

```
1:      16      Reps
2:      47      Loc [ BlockC_1 ]
```

## ST-13 ARGOS SATELLITE TRANSMITTER

```

;
; ** Zero Counter **

30: Z=F (P30)
  1:      0      F
  2:      0      Exponent of 10
  3:     64      Z Loc [ Counter ]
;
; ** Zero 90 second timer for next interval **

31: Timer (P26)
  1:     63      Loc [ Timer ]
;
; ** Send 16 Datapoints to ST5 Buffer #1 and Transmit **
;
;>>> OR USE 16 INSTEAD OF 48 IN THE FIRST BYTE <<<
;>>> 16 WILL ONLY DUMP DATA AND NOT TRANSMIT <<<

```

```

32: Data Transfer to ARGOS ST-13 (P121)
  1:     48      Command Byte #1
  2:    0000      Command Byte #2
  3:    0000      Command Byte #3

```

```

;
; ** P95 End if Counter = 3 **

```

```

33: End (P95)
;
; ** End if Timer = 90 **

```

```

34: End (P95)

```

```

*Table 2 Program
  02: 0.0000 Execution Interval (seconds)

```

\*Table 3 Subroutines

End Program

1	[ Meas__1 ]	R---	1	0	-----
2	[ Meas__2 ]	R---	1	0	-----
3	[ Meas__3 ]	R---	1	0	-----
4	[ Meas__4 ]	R---	1	0	-----
5	[ Meas__5 ]	R---	1	0	-----
6	[ Meas__6 ]	R---	1	0	-----
7	[ Meas__7 ]	R---	1	0	-----
8	[ Meas__8 ]	R---	1	0	-----
9	[ Meas__9 ]	R---	1	0	-----
10	[ Meas__10 ]	R---	1	0	-----
11	[ Meas__11 ]	R---	1	0	-----
12	[ Meas__12 ]	R---	1	0	-----
13	[ Meas__13 ]	R---	1	0	-----
14	[ Meas__14 ]	R---	1	0	-----
15	[ BlockA_1 ]	RW--	1	1	Start -----
16	[ BlockA_2 ]	RW--	1	1	----- Member ---
17	[ BlockA_3 ]	RW--	1	1	----- Member ---

# ST-13 ARGOS SATELLITE TRANSMITTER

18	[ BlockA_4 ]	RW--	1	1	----- Member ---
19	[ BlockA_5 ]	RW--	1	1	----- Member ---
20	[ BlockA_6 ]	RW--	1	1	----- Member ---
21	[ BlockA_7 ]	RW--	1	1	----- Member ---
22	[ BlockA_8 ]	RW--	1	1	----- Member ---
23	[ BlockA_9 ]	RW--	1	1	----- Member ---
24	[ BlockA_10 ]	RW--	1	1	----- Member ---
25	[ BlockA_11 ]	RW--	1	1	----- Member ---
26	[ BlockA_12 ]	RW--	1	1	----- Member ---
27	[ BlockA_13 ]	RW--	1	1	----- Member ---
28	[ BlockA_14 ]	RW--	1	1	----- Member ---
29	[ BlockA_15 ]	RW--	1	1	----- Member ---
30	[ BlockA_16 ]	RW--	1	1	----- End
31	[ BlockB_1 ]	RW--	2	1	Start -----
32	[ BlockB_2 ]	RW--	2	1	----- Member ---
33	[ BlockB_3 ]	RW--	2	1	----- Member ---
34	[ BlockB_4 ]	RW--	2	1	----- Member ---
35	[ BlockB_5 ]	RW--	2	1	----- Member ---
36	[ BlockB_6 ]	RW--	2	1	----- Member ---
37	[ BlockB_7 ]	RW--	2	1	----- Member ---
38	[ BlockB_8 ]	RW--	2	1	----- Member ---
39	[ BlockB_9 ]	RW--	2	1	----- Member ---
40	[ BlockB_10 ]	RW--	2	1	----- Member ---
41	[ BlockB_11 ]	RW--	2	1	----- Member ---
42	[ BlockB_12 ]	RW--	2	1	----- Member ---
43	[ BlockB_13 ]	RW--	2	1	----- Member ---
44	[ BlockB_14 ]	RW--	2	1	----- Member ---
45	[ BlockB_15 ]	RW--	2	1	----- Member ---
46	[ BlockB_16 ]	RW--	2	1	----- End
47	[ BlockC_1 ]	RW--	2	1	-----
48	[ BlockC_2 ]	R--	2	0	-----
49	[ BlockC_3 ]	R--	2	0	-----
50	[ BlockC_4 ]	R--	2	0	-----
51	[ BlockC_5 ]	R--	2	0	-----
52	[ BlockC_6 ]	R--	2	0	-----
53	[ BlockC_7 ]	R--	2	0	-----
54	[ BlockC_8 ]	R--	2	0	-----
55	[ BlockC_9 ]	R--	2	0	-----
56	[ BlockC_10 ]	R--	2	0	-----
57	[ BlockC_11 ]	R--	2	0	-----
58	[ BlockC_12 ]	R--	2	0	-----
59	[ BlockC_13 ]	R--	2	0	-----
60	[ BlockC_14 ]	R--	2	0	-----
61	[ BlockC_15 ]	R--	2	0	-----
62	[ BlockC_16 ]	R--	2	0	-----
63	[ Timer ]	RW--	1	4	-----
64	[ Counter ]	RW--	3	2	-----



## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

### A.1 SCOPE

This document is intended to provide the user with the information needed to understand the serial interface capability of the ST-13. It provides an overview of the ST-13 and defines the hardware configuration and logical interface in sufficient detail to allow direct command and control operation of the ST-13 via the user's host computer system. The Hardware Configuration and the Electrical Interface sections of this manual define the voltage levels, pinouts and pin-loading specifications for the hardware link between the ST-13 and the host system. The Serial Communications and Commanding sections describe the logical software protocol used for passing commands from the host computer to the ST-13, and the ST-13's response back to the host.

### A.2 OVERVIEW

The ST-13 is a certified ARGOS PTT (Platform Transmitter Terminal). It may be interfaced to a user's data collection system, providing uplink capability for the user's experiment. The ST-13 contains a full-duplex asynchronous serial communications interface through which the host computer of the user's data collection system may transfer any data to the ST-13 that are to be transmitted to the satellite. ST-13 RF messages are transmitted via the ARGOS DCLS on board NOAA polar orbiting satellites. Because the ST-13 directly controls the RF uplink (i.e., modulation, timing, and failsafe shut-down) and is already certified, the user's composite system does not have to undergo the rigorous ARGOS certification process.

The ARGOS system can support several concurrent experiments. Each experiment is totally independent and may transmit data to the satellite at almost any time. ARGOS confines each experiment to a specified transmission rate. Since many independent experiments may be transmitting data to the same satellite at nearly, or even exactly the same time, ARGOS sorts the received data so that they can be routed back to the proper owner. To accomplish this, ARGOS assigns a unique ID code to each experiment. In addition to the data transferred from the host computer system to the ST-13,

these ID codes are also part of every transmission sent by the ST-13.

ID codes must be acquired from ARGOS by the experiment owner, and presented to Telonics when an ST-13 is ordered. These ID codes are generally programmed into the ST-13 before it leaves the factory. Each ST-13 can support up to 8 ID codes. This allows for one PTT to perform multiple experiments, or for a single experiment to transmit more data than can be transmitted via a single ID code. Note that data are transmitted in multiples of 32-bit words (4-bytes per word). The shortest data message is 1 word (4 bytes) and the longest is 8 words (32 bytes). Each ID code assigned by ARGOS has associated with it a message length in number of words, and each transmission using a given ID code must transmit the correct number of words. Therefore, the message length for each ID code must also be programmed into the ST-13, usually at the factory.

Therefore, when the host wishes to send data to the ST-13, it sends a command byte which specifies the function to be performed (such as **Store Data** or **Transmit**), and an ID code to associate with the data being passed or transmitted. Because message length is already assigned to each ID code, specifying an ID code indirectly specifies to the ST-13 the number of data words, hence, the number of bytes to be transferred or transmitted. Since up to 8 ID codes may be stored in the ST-13, specifying an ID code is accomplished by passing a number between 0 and 7 which acts as an index into the ST-13's internal table of stored ID codes. This index number is actually part of the passed command byte.

All message data passed to the ST-13 is stored in one of two internal buffers, known as buffer 1 and buffer 2. The host computer specifies which buffer is to be used by way of the specified command. For instance, the Store Data 1 command stores data into buffer 1, and the Store Data 2 command stores data into buffer 2. This allows the host greater flexibility in handling the data to be transmitted.

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

As can be seen, the data that the ST-13 transmits comes from the host computer. When these transmissions occur, however, is another matter. Initiation of transmissions may be controlled by either the host computer or the ST-13. The ST-13 supports commands that initiate transmissions under the auspices of the host computer. This puts the entire burden of when transmissions occur upon the host. The ST-13 also supports a mode known as Auto-Repeat, which allows the host to tell the ST-13 when to begin a series of up to 255 transmissions without any further intervention by the host. This mode can greatly lighten the burden on the host. Note that it is typical for the same message to be transmitted several times in order to ensure successful reception of the data by a satellite. The Auto-Repeat mode is extremely useful for accomplishing this function.

Examination of Figures A-3, A-4, and A-5, shows that transmissions consist of long serial streams of data. Although the host computer may be in charge of when transmissions occur, there is no need for the host to worry about any of the details of the transmission itself. The ST-13 handles all of the serial data stream generation and the complex timing of the entire transmission.

The ST-13 supports two additional modes which are unique enough to bear introduction. The ST-13 constantly monitors the quality of the communication link with the host computer, and can identify several types of errors, should they occur. It maintains a history of the most recent errors and a count of the total number of errors that have occurred. If the ST-13 were to keep this information to itself, it would be useless. Therefore, a mode, known as Transmit Error Counts, is supported to allow the ST-13 to inject this information into the host's data message. When this mode is turned on, the ST-13's internal error information is included in the data message, which allows the experiment owner to monitor conditions internal to the system. This mode can identify communication problems between the host and the ST-13 during the user's development phase, as well as show degrading conditions (such as might occur due to water leakage) which can greatly assist in understanding system failures in the field. This mode may be turned on and off by the host computer at any time. (Note that this mode may be permanently disabled at the time an ST-13 is ordered.)

The ST-13 also supports a mode known as FailSafe. With this mode enabled, should a catastrophic communications link failure occur between the host computer and the ST-13, the ST-13 can detect when a preset time limit has expired without successfully receiving a command from the host computer. This time limit is specifiable when the ST-13 is ordered, and may be set from one minute to 255 days. If this condition is detected, the ST-13 will begin transmitting a FailSafe message, which will include the error count and history information described above. These FailSafe transmissions, while not conveying any useful experiment data, may be useful in discerning the reason for the failure, and may be used to position fix the troubled PTT. (Note that this mode may be permanently disabled at the time an ST-13 is ordered.)

### A.3 SERIAL COMMUNICATION - HARDWARE CONFIGURATION

The ST-13 may be ordered with either a TTL (5 volt) or RS-232 interface. Connection to the ST-13 for the purpose of control via the asynchronous serial port is accomplished using a male DB-25 connector (refer to Appendix A, "ST-13 I/O Connector Pinouts"). The pin connections at the ST-13 are as follows:

Pin 1 --	Async Wake-up Signal:  TTL: This line is pulled high (+5V) at the ST-13 through a 100K Ohm resistor. Pulling this line low will cause a wake-up interrupt in the ST-13.  RS-232: This line is pulled to ground through a 30K Ohm resistor. The idle state of this line is low (0 to -15V). Pulling this line high (+5 to +15V) will cause a wake-up interrupt.
Pin 2 --	TXD: Used to transmit data from the ST-13 to the host.

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

TTL: This line is normally at +5V and pulled low for Start bits and Zero bits. One bits are represented by +5V. This line will remain at +5V even when the ST-13 is between commands from the host.

RS-232: This line is driven by a RS-232 line driver. When the ST-13 is awake and communicating with the host, the idle state of this line is low (-5 to -15V). Start bits and Zero bits are transmitted with this line in the high state (+5 to +15V). One bits are transmitted with this line in the low state (-5 to -15V). Note that when the ST-13 is NOT communicating with the host (i.e., between commands), the RS-232 driver chip is powered down to save battery power. This causes the TXD pin to be pulled toward 0V. The host system MUST be aware of this and disable its receiver during this time.

Pin 13 -- Common ground for transmit, receive and wake-up signals.

Pin 14 -- RXD: Used by the ST-13 to receive data from the host.

TTL: This line is normally pulled high (nominal +5V) at the ST-13 through a 1 meg Ohm resistor. This line is to be pulled low by the host for Start bits

and Zero bits, and left high for One bits.

RS-232: This line is connected to a RS-232 line receiver which has an internal 5K Ohm resistor to ground. The host should hold this line low (-5 to -15V) for the idle state and for One bits. The line should be driven high (+5 to +15V) for Start bits and Zero bits.

Pin 22 --

CR: +5 volt source used in some applications requiring pull-ups.

**WARNING:** When using the TTL interface, exceeding +5.5V on any pin may damage the ST-13. Inputs are static sensitive.

**NOTE:** For the TTL interface option, the polarity of the TXD and RXD signals exactly matches the corresponding pins on most UARTs. This typically allows for direct connection between the ST-13 and the host's UART.

### A.4 ELECTRICAL INTERFACE AND I/O PIN LOADING

Figure A-1 illustrates the termination of the serial I/O pins internal to the ST-13 for the TTL interface option. Each pin is RF filtered. A series 10K resistor current limits the pins and protects from nominal over-voltage conditions and static. Each pin has a pull-up resistor to +5v.

In order to overcome the 220 pF capacitive loading on the input pins to the ST-13, each input should be driven by a device in the host with an active pull-up. This works well when the host and the ST-13 will always be powered up together. However, if the host is always going to be powered up and the ST-13 is going to be powered down for extended periods, the active drivers in the host will cause supply current to be wasted by attempting to hold the ST-13's input pins high.

In instances requiring the ST-13 to be powered down for long periods of time, it is advisable to

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

use open-collector or open-drain transistors to drive the ST-13 input pins. When doing this, it is necessary to add additional 100K pull-up resistors between pin 22 (CR) and pins 1 and 14 (Wake-Up and RXD) on the ST-13's I/O connector. This is because the pull-up resistors internal to the ST-13 (100K and 1M respectively) are insufficient to overcome the capacitive loading and leakage current of the driving transistor, especially at higher baud rates.

Pin 2 of the ST-13 I/O connector (TXD) is driven by an active device internal to the ST-13. The internal series 10K resistor protects this device from external shorts. Make sure that the pin

which receives this signal in the host has an input impedance much larger than 10K ohms. If the ST-13 is powered-down, it will tend to drag this pin low.

Figure A-2 illustrates the termination of the serial I/O pins internal to the ST-13 for the RS-232 interface option. Each pin is RF filtered. The Wake-Up pin has 30K of resistance to ground. The TXD and RXD pins come directly from a RS-232 driver/receiver chip. Note that this chip is powered on when a Wake-Up signal is received, and powered off after reception of the complete command from the host.

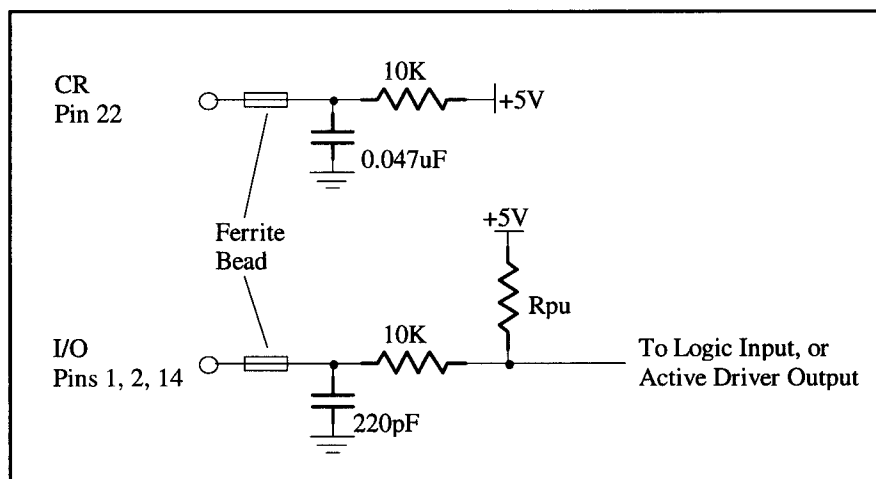


FIGURE A-1. Serial I/O, TTL Termination

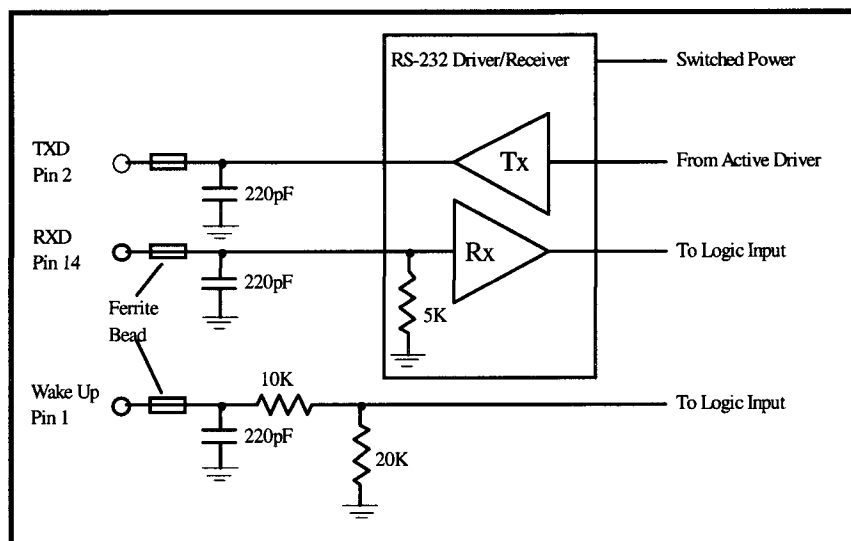


FIGURE A-2. Serial I/O, RS-232 Termination



### A.5 SERIAL COMMUNICATION PROTOCOL

The serial communication capability supported by the ST-13 is as follows:

- Asynchronous serial utilizing standard NRZ format.
- One start bit, eight data bits, one stop bit, no parity.
- Supports baud rates of 300, 600, 1200, and 2400.
- Data is transmitted least significant bit first.

### A.6 COMMANDING

Controlling the ST-13 is accomplished by passing commands from the host computer to the ST-13 via an asynchronous serial link. The serial link can be uni-directional or bi-directional depending on the user's needs.

If the serial link is uni-directional, it simply means that the host transmits commands to the ST-13 and ignores any response from the ST-13. This can be accomplished by not connecting the ST-13's TXD line to the RXD line of the host's UART. In this mode, the host doesn't know whether or not its command was received and accepted by the ST-13.

As an alternative, the user can choose to have the host's commands acknowledged via a bi-directional link. In this mode, every host command will be acknowledged with an ACK (positive acknowledge) or a NAK (negative acknowledge) depending on whether or not the command was successfully received and executed by the ST-13. The choice by the user to use acknowledgment is made by connecting the ST-13's TXD line to the host UART's RXD pin.

#### A.6.1 COMMAND DATA

Command bytes and data bytes sent from the host to the ST-13 are always 8-bit binary values. They are not ASCII characters. The user must ensure that the host's UART is configured to send complete 8-bit values without parity.

#### A.6.2 COMMAND INITIATION

The host computer initiates each command by activating the wake-up line to the ST-13. The wake-up line requires a momentary active signal (low for the TTL option, high for the RS-232 option) from 25 - 100 milliseconds in duration, after which it must be reset to its idle state. The host must wait at least one millisecond after the wake-up signal has been returned to the idle state before it initiates the serial transmission of the command byte. After the delay, the host transmits the command byte followed by any additional data bytes appropriate for that particular command.

After the ST-13 receives the command and data from the host, the ST-13 will respond with an ACK if the command is valid, or a NAK if the command is not valid. After sending its response, the ST-13 will then go back to sleep, and must be re-awakened before another command can be transmitted from the host.

Execution of a command in the ST-13 takes a period of time dependent upon the command itself. The wake-up pulse for the next command to be issued to the ST-13 should be delayed after the last byte of the current command is transferred. This is to allow sufficient execution time for the current command, and will guarantee that the next command will be correctly received by the ST-13. The length of the required delay is described below:

Commands that do not invoke a transmission of data are typically completed nearly immediately after the last byte is received. In these cases, a delay of only 100 milliseconds is required prior to the next command.

However, if the command initiates a transmission, the ST-13 may be busy for up to 3 seconds. Therefore, a delay of 3 seconds is required prior to the next command.

If the TTL interface option is used, the following procedure is highly recommended. Any commanding sequence should begin with the host computer sending one or more NULL commands (binary 10110000). In addition, the user is encouraged to use the command acknowledgment feature as defined in the next paragraph. When the ST-13 responds to a NULL command with an ACK, the host is assured that any spurious bits in either the host's serial transmitter or the ST-13's serial receiver

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

have been cleared out and the serial link is functioning properly. The NULL command causes no action in the ST-13 other than the transmission to the host of the ACK byte. If the serial link is functioning correctly (as defined by the transmission by the host of one or more NULL commands and the receipt of the appropriate number of ACKs from the ST-13) then normal commanding may continue. If more than one or two NAKs are received during this procedure, it is safe to assume that there is some fundamental hardware or software problem that needs to be addressed. Adherence to this procedure will increase the probability of successful commanding of the ST-13.

If the RS-232 interface option is used, the above procedure is not recommended since the RS-232 driver/receiver chip in the ST-13 is powered down between all commands. Therefore, it is even more strongly recommended that the command acknowledgment feature described below be used.

### A.6.3 ST-13'S RESPONSE

The ST-13 will respond to all attempts by the host to send commands. After receiving the entire command (command byte plus any additional data bytes) the ST-13 will respond by sending to the host either an ACK (00000110), if the command was successful, or a NAK (00010101) if the command was not successful. If, after three seconds, the host has not received an acknowledgment, the ST-13 should be re-awakened and the command retransmitted. However, if five unsuccessful attempts with the same command have been made, it is probable that a serious interface problem (such as moisture penetration) has corrupted the interface. Under this circumstance, it is suggested that the host abort the commanding attempt with the unsuccessful command as it is highly unlikely that it will be successful and will only consume battery power. The user may want to attempt commanding again at a later time, in the hope that the problem has cleared itself.

Please refer to Appendix C for timing sequences and description of the serial I/O.

### A.6.4 COMMAND TIME-OUT

When the ST-13 receives a Wake-Up signal it starts a "watch dog" timer running. If it does not receive a complete command (that is a command byte and all additional data bytes)

within two seconds, the following sequence occurs: 1) a "time out" situation is declared, 2) the read operation is aborted, 3) the ST-13's internal error counters are incremented, 4) a NAK is sent to the host, 5) the RS-232 driver/receiver chip is powered down (if RS-232 option installed), and 6) the ST-13 goes back to sleep.

### A.6.5 COMMANDS

As mentioned earlier, the host controls the ST-13 by use of commands. These commands take the form of single byte (8 bit) values which define operations to be performed by the ST-13. The commands are as follows:

Command (Binary)	Function
(1) 00010xxx	<b>Store Data 1:</b> Store the data (8 bit binary values) following the command byte in ST-13 Buffer Number 1, but do not transmit. The "xxx" value is used to specify an index into the ST-13's internal table of 8 possible ARGOS ID Codes. The value of "xxx" varies from zero (000) to seven (111) and specifies which ID Code will be used to identify the user's data when it is transmitted. The index also indirectly specifies the number of data bytes to be transferred following the command byte. The ARGOS ID Codes which are programmed into the ST-13 at the factory include ARGOS message data length specifications. The data length can be expressed as 4, 8, 12, 16, 20, 24, 28, or 32 bytes.

Any combination of ARGOS ID codes and message lengths can be programmed into any index position. In the majority of cases, a

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

single ID code and associated message length are required. In this case, index 0 is used.

If an insufficient number of data bytes is received from the host, the system error counter is incremented, the operation is aborted, and Buffer Number 1 is marked as containing no data. If any Auto-Repeat operation is in progress at this time, it will be canceled in order to avoid transmitting invalid data.

If the host transfers bytes in excess of that specified by the ARGOS ID Code, the surplus bytes are ignored, but the initial bytes are stored in Buffer Number 1 (no error code is generated).

The following table defines the relationship between the command and the specified ARGOS ID Code index. The actual ARGOS ID codes are assigned to the user by ARGOS, provided to Telonics by the user, and programmed into the ST-13 prior to shipment from the factory. Note that each ARGOS ID Code is associated with a message length code which specifies the number of 4-byte data groups to be transmitted when a particular ARGOS ID Code is used. If desired, any given ARGOS ID Code can

be replicated in the ST-13's internal table. This would permit the user to transmit any 4 byte data increment from 4 to 32 bytes using the same ARGOS ID Code, if appropriate.

Command Byte			ID Index
Binary	Hex	Decimal	
00010000	\$10	16	1
00010001	\$11	17	2
00010010	\$12	18	3
00010011	\$13	19	4
00010100	\$14	20	5
00010101	\$15	21	6
00010110	\$16	22	7
00010111	\$17	23	8

(2) 00100xxx **Store Data 2:** Store the data bytes following the command byte in ST-13 Buffer Number 2. This command is exactly like the previous command except the data are directed to Buffer Number 2.

(3) 00110xxx **Store and Transmit 1:** Store the following data in Buffer Number 1 and transmit it immediately. This command is identical to the first command except that the data is immediately transmitted. The time between initiation of the command and completion of the transmission can be as long as 8 seconds. No other commands concerning Buffer Number 1 should be initiated in this time frame to assure that transmission of an intact buffer occurs.

(4) 01000xxx **Store and Transmit 2:** Same as above, except that data will be stored

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

		in Buffer Number 2 and then immediately transmitted.			the system error counter is incremented. The time between initiation of the command and completion of the transmission can be as long as 8 seconds. No other commands concerning Buffer Number 2 should be initiated in this time frame to assure that transmission of an intact buffer occurs.
(5)	01010xxx	<b>Transmit 1:</b> Transmit the data previously stored in Buffer Number 1. No data follows this command byte. The three bit value "xxx" specifies one of a possible eight (0-7) different ARGOS identification codes. If the data message length associated with the selected identification code is inconsistent with the length of the data stored in Buffer Number 1, the operation is aborted and the system error counter is incremented. The time between initiation of the command and completion of the transmission can be as long as 8 seconds. No other commands concerning Buffer Number 1 should be initiated in this time frame to assure that transmission of an intact buffer occurs.	(7)	01110zyx	<b>Auto-Repeat:</b> Automatic repeat RF transmission command. This command consists of one or three bytes, depending on whether default values are used for repetition rate and repetition count. If the default value option is selected (bit "y" set to 1), then the entire command consists of one byte. Otherwise, the host supplies the repetition rate and count (bit "y" set to 0) and the command consists of three bytes. The least significant bit of the first byte (x) specifies which buffer holds the message which is to be repeated. If "x" is zero, Buffer Number 1 will be repeated; if "x" is one, Buffer Number 2 will be repeated. If bit "z" is set to 1, Buffer Number 1 and Buffer Number 2 will be transmitted alternately. When alternate buffer transmission is selected, bit "x" specifies which buffer will be transmitted first. As before, if "x" is zero, Buffer Number 1 is specified.
(6)	01100xxx	<b>Transmit 2:</b> Transmit the data previously stored in Buffer Number 2. No data follows this command byte. The three bit value "xxx" specifies one of a possible eight (0-7) different ARGOS identification codes. If the data message length associated with the selected identification code is inconsistent with the length of the data stored in Buffer Number 2, the operation is aborted and			

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

<p>The second command byte specifies the repetition rate in seconds added to a base of 42 seconds. In other words, a specification of zero seconds would cause a message to be transmitted every 42 seconds. A specification of the maximum repetition rate (255) will cause a message to be transmitted every 297 seconds (42+255). The third command byte specifies the number of repetitions (range 1 to 255). Successful execution of this command requires that the specified buffer was previously set up using either Command 1 or 2 (the Store Data commands). If the specified buffer was not previously set up and this command is given, a NAK is sent to the host, and the system error counter is incremented.</p>	(8)	10000000	<p>and installed at the time the ST-13 is ordered.</p>
<p>If bit "y" is one, then this command consists of only the command byte. The repetition rate normally supplied in byte 2 and the repetition count normally residing in byte 3 are provided as default values stored in the ST-13's ROM. The ST-13's ROM contains eight sets of repetition rates and repetition counts (16 bytes total). Each set corresponds to one ARGOS ID code. These default values can be user-specified</p>	(9)	10110000	<p><b>Cancel Auto-Repeat:</b> Cancel automatic repeat RF transmission function initiated via Command 7 (Auto-Repeat). This command can be used to terminate an automatic repeat transmission operation before it has completed all of the programmed iterations. This command should be used to cancel any auto-repeat operations before attempting to load new data into either buffer.</p> <p><b>Null Command:</b> This is a single byte command. It does not cause transmission. It may be sent periodically to let the ST-13 know that the host is still properly functioning so that the ST-13 will not enter a FailSafe mode of operation. The ST-13 will respond by sending an ACK to the host so the host may know that the serial interface is OK.</p>
<p>The repetition rate normally supplied in byte 2 and the repetition count normally residing in byte 3 are provided as default values stored in the ST-13's ROM.</p>	(10)	11000000	<p><b>Disable TEC:</b> Disable Transmit Error Counts mode. This is a single byte command. See "Enable TEC" command for details of TEC mode.</p>
<p>The ST-13's ROM contains eight sets of repetition rates and repetition counts (16 bytes total). Each set corresponds to one ARGOS ID code. These default values can be user-specified</p>	(11)	11010000	<p><b>Enable TEC:</b> Enable Transmit Error Count mode. This is a single byte command. This command causes the "Error Count Marker," the "Error Count," and the four most recent</p>

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

error codes (total of 4 bytes) to be transmitted in the first 4 bytes of the data portion of the ARGOS message. The error codes are allocated as four 4-bit values. The ARGOS message format when transmitting error codes is presented in the paragraph titled "Message Format with Transmit Error Counts." The following table presents the error codes and definitions:

(12) 11100000

**Disable FailSafe:**  
Disable FailSafe mode. This command must be followed by 16 bytes of hexadecimal qualification data as follows:

AA,AA,AA,AA,  
AA,AA,.....AA,AA,AA.

The value "AA" is 10101010 in binary. This command resets the internal counter which controls FailSafe duty cycle.

Error Code  
(binary)

Definition

(13) 11110000

**Enable FailSafe:** This single byte command is used to enable the FailSafe mode of operation. This command starts (but does not reset) the internal time counters controlling FailSafe duty cycle. See section of manual titled FAILSAFE MODE for details.

0000	No error (OK)
0001	FailSafe time-out.
0010	Illegal command from host.
0011	ARGOS ID Code index not legal. The index value is greater than the number of ID Codes stored in the ST-13.
0100	Size of data residing in requested buffer is inconsistent with the specified ARGOS ID
0101	Host took more than 2 seconds to complete transmitting data following "wake-up" signal to ST-13.
0110	ST-13 UART detected overrun.
0111	ST-13 UART detected line noise.
1000	ST-13 UART detected a framing error (stop bit not in position).
1001	Auto Repeat -- Buffer requested by host not valid (does not contain any data).
1010	Auto Repeat -- Zero transmission iterations specified by host.

### A.7 ST-13 ARGOS MESSAGE FORMAT (UPLINK MESSAGE)

#### A.7.1 MESSAGE FORMAT WITHOUT TRANSMIT ERROR COUNTS

The complete transmission sequence consists of receiver synchronization bits, frame synchronization bits, message length code, user identification code, and from one to eight data words that consist of four bytes each. The data portion of the transmission is exactly as received from the host computer. See ARGOS' technical documents for additional information.

APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

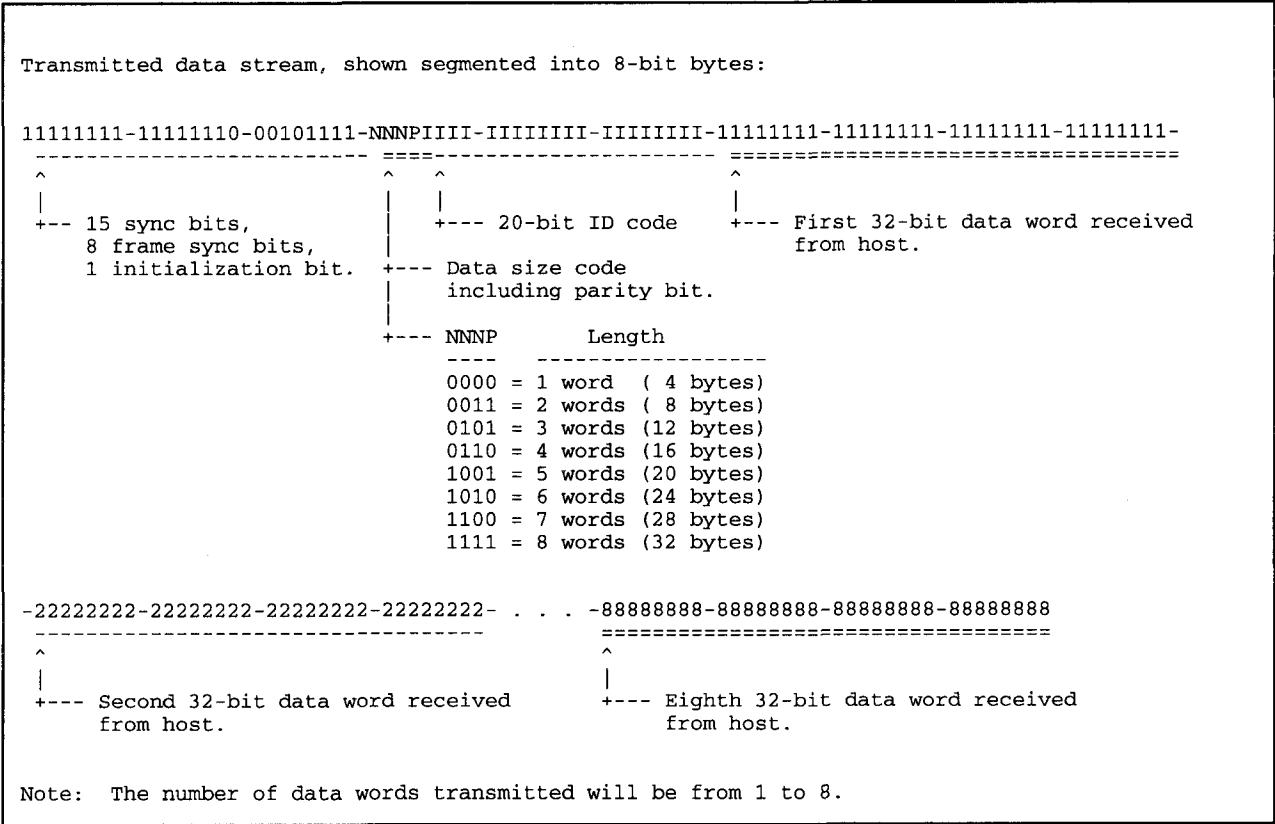


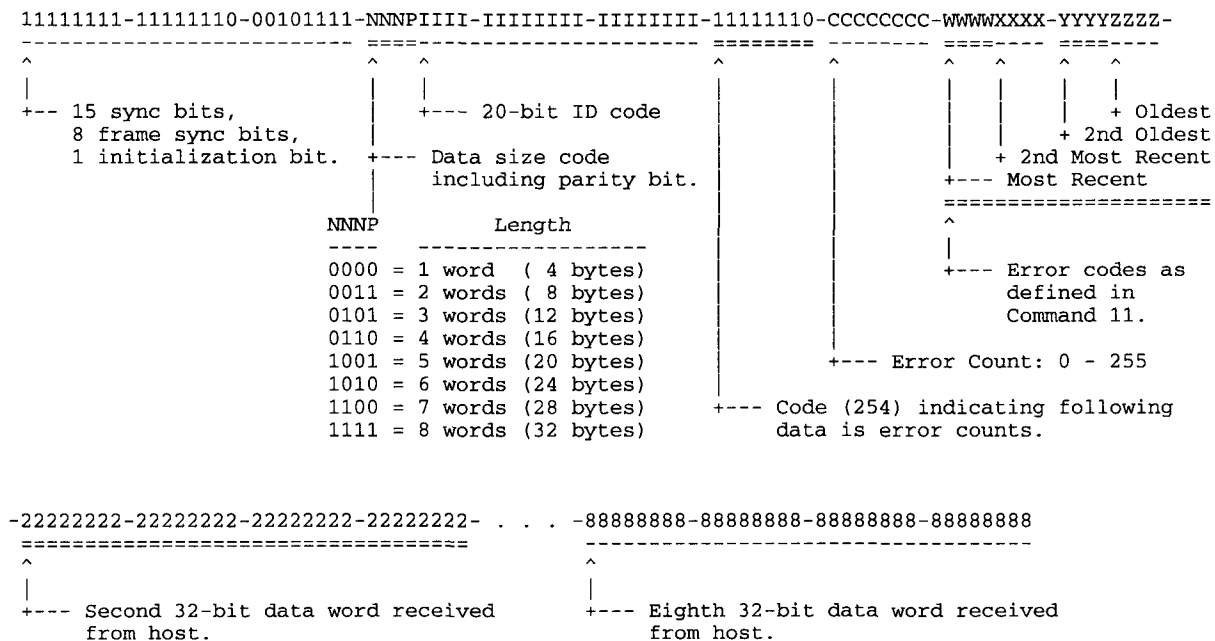
FIGURE A-3. Message Format without Transmit Error Counts

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

### A.7.2 MESSAGE FORMAT WITH TRANSMIT ERROR COUNTS

When the "Transmit Error Counts" mode is active, the transmission sequence is exactly as in Figure A-3 except that the first data word (four bytes) is overwritten by the Error Count Marker, Error Counter, and most recent four Error Codes.

Transmitted data stream, shown segmented into 8-bit bytes:



- Note:
- 1) The error count data and the error codes overwrite the first 32-bit data word received from the host.
  - 2) The four values XXXX, XXXX, YYYY, and ZZZZ are four-bit error codes as defined in command 11 (Enable TEC). These codes will be shifted right four bits at a time as new errors are detected. The most recent error is XXXX.
  - 3) The number of words transmitted will be from 1 to 8.

FIGURE A-4. Message Format with Transmit Error Counts



### A.8 FAILSAFE MODE

The FailSafe mode of operation is intended to provide a means of locating an ST-13 in the event that the host becomes incapable of commanding the ST-13. If the FailSafe mode is enabled and the host has not successfully commanded the ST-13 for longer than the user-specified period, and the ST-13 is not actively engaged in an "automatic repeat transmission" mode, the ST-13 will begin transmitting FailSafe messages. The FailSafe message will be transmitted at a rate not less than 42 seconds or more than 255 seconds as specified by the researcher and programmed into the ST-13 at the factory. The first four bytes of FailSafe messages always contain an error count, and up to four of the most recent error codes. The remainder of the message (0 to 28 bytes) can be user-specified.

FailSafe transmissions are also controlled by an on/off duty-cycle that is factory settable. As an example, the duty-cycle could be such that FailSafe messages would be transmitted six hours out of 24; during the other 18 hours no transmissions would take place. The initialization of this duty-cycle can be accomplished by power-down/power-up of the ST-13.

In addition, for those who have chosen a FailSafe option which allows the host to disable and enable FailSafe (refer to Appendix B, Item 4), the initialization of the time counters can be accomplished in the following manner: The internal time counters are reset whenever the ST-13 receives a "Disable FailSafe" command from the host; the "Enable FailSafe" command then allows these counters to start counting.

If you wish to reset the FailSafe counters to initialize the beginning of the duty-cycle, an appropriate action for the host to take when initializing the system is as follows:

- A. Apply power to ST-13.
- B. Apply power to host.
- C. When ready to initialize the duty-cycle timer, send a "Disable FailSafe" command to the ST-13 to reset the counters. (This may occur at any time after power-up.)
- D. Immediately send an "Enable FailSafe" command to the PTT to start the counters.
- E. Enter Normal data collection and sending mode.

Example: The system is to be initialized at 12:00 Zulu time. At 12:00 Zulu, the host sends a "Disable FailSafe" command to the transmitter, followed by an "Enable FailSafe" command. The host should never again send the "Disable" command, although multiple "Enable" commands may be sent with no ill effects.

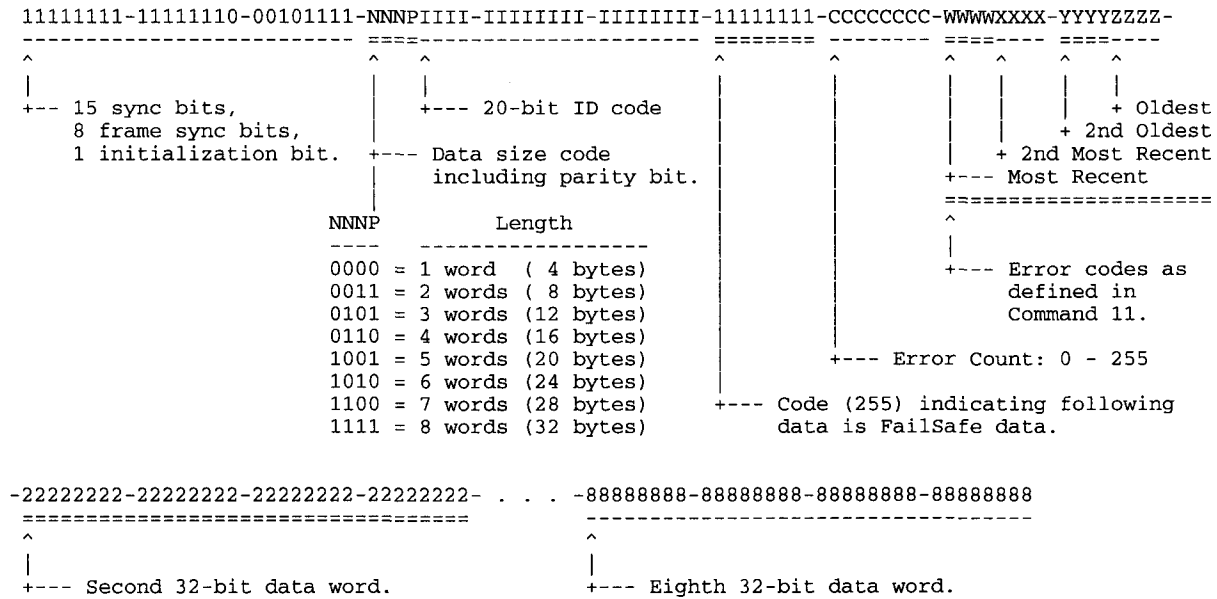
If the ST-13's ROM contains FailSafe "on" duty-cycle time set for 6 hours, and FailSafe "off" duty-cycle time set for 18 hours, and if the ST-13 determines that a FailSafe condition should be activated, any and all FailSafe transmissions will occur between 12:00 and 18:00 Zulu time. Generally, it is desirable for the "on" period to occur during the period of time in which it is most likely for a satellite to be in view. The length of the "on" period directly affects the probability of obtaining an uplink to the satellite. The longer the "on" period, the greater the possibility of successful message transfer and position determination.

#### A.8.1 FAILSAFE MESSAGE FORMAT

When the "FailSafe" mode is active, the transmission sequence is exactly as in Figure A-3 except that the first data word (four bytes) is the Error Count Marker, Error Counter, and most recent four Error Codes. The length of the FailSafe transmissions may be from 1 to 8 words long, as specified at the time the ST-13 is ordered. The first word will always consist of the Error Count information. If any additional words are to be sent, their content must also be specified at the time the ST-13 is ordered.

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

Transmitted data stream, shown segmented into 8-bit bytes:



- Note:
- 1) The error count data and the error codes comprise the first 32-bit data word.
  - 2) The number of words transmitted may be from 1 to 8 as specified when the ST-13 is ordered. Any additional data words must also be specified when the ST-13 is ordered.
  - 3) The four values WWWW, XXXX, YYYY, and ZZZZ are four-bit error codes as defined in command 11 (Enable TEC). These codes will be shifted right four bits at a time as new errors are detected. The most recent error is WWWW.

**FIGURE A-5. FailSafe Message Format**

## A.9 ST-13 INPUT/OUTPUT CONNECTOR PINOUTS

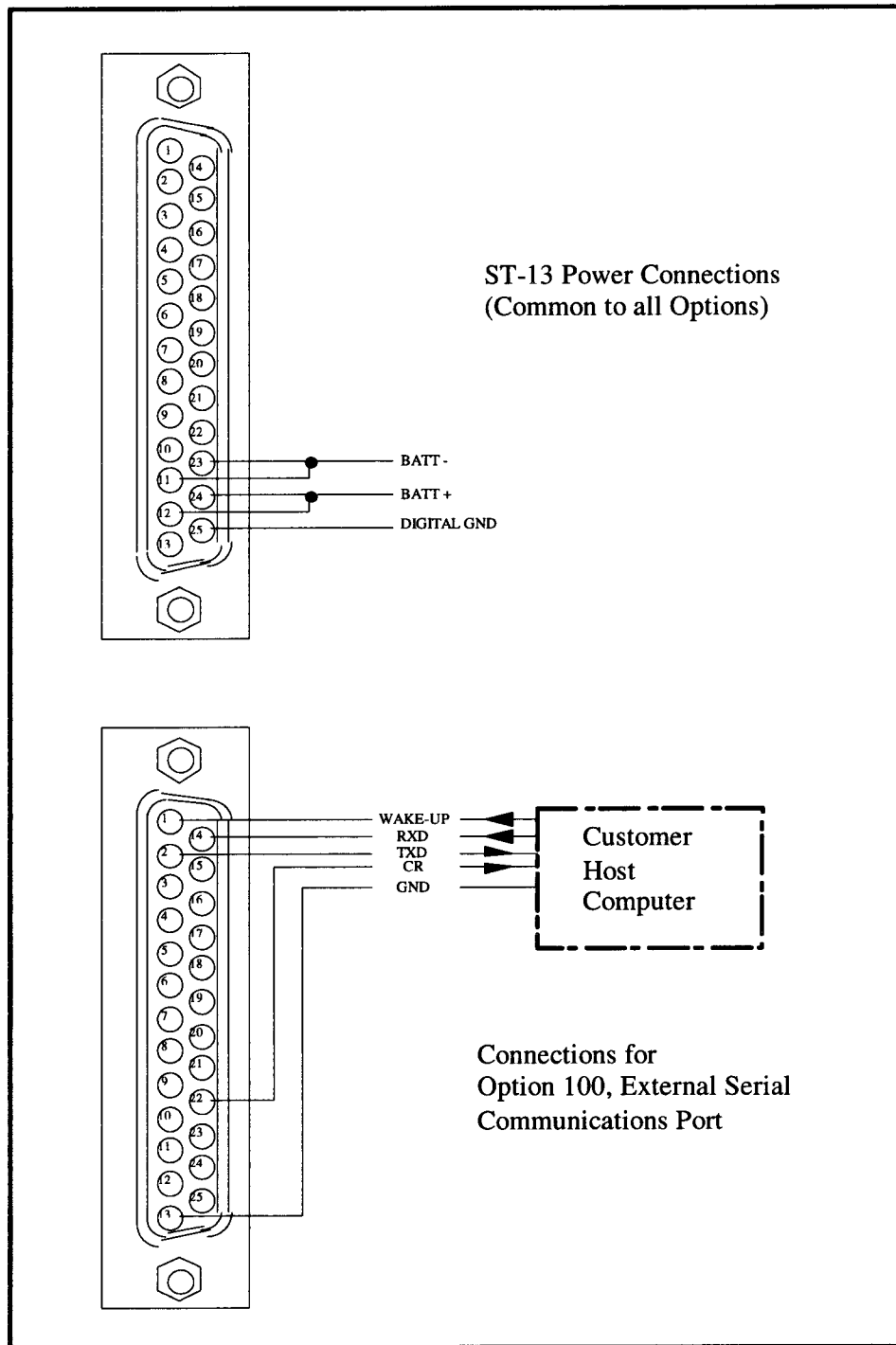


FIGURE A-6. ST-13 I/O Connector Pinouts

### A.10 ASYNCHRONOUS INTERFACE PARAMETERS

Asynchronous Interface Parameters to be selected by the user at time of purchase, and to be provided to Telonics in writing.

1) The ST-13 can communicate with the host at 2400, 1200, 600, or 300 baud. Please select.

2) One to eight ID Codes may be programmed into the ST-13. The user must specify each ID Code and the message length to be transmitted with each ID Code. In addition, if the "Auto Repeat" command will be used with the default repetition count and repetition rate, then these values must be supplied for each ID code. Message length can be 4,8,12,... or 32 bytes, and can be individually selected for each ID Code. ID Codes are assigned by ARGOS and are related to message length in the ARGOS Technical File.

3) A "Transmit Error Counts" mode is available. In this mode the first 4 bytes of each transmitted message contain an error count plus the most recent error codes. Please select whether this mode should be available (if so, user can switch on and off as desired), or if the mode is not to be available. Additional information is available in the **User's Manual**.

4) A "FailSafe" mode is available. If FailSafe is enabled, and a user specified period is exceeded without communication from the host, the PTT will begin to transmit the FailSafe ID Code and error codes at the specified repetition rate and duty cycle. The **User's Manual** contains additional information regarding FailSafe. Please select one of the following four options regarding FailSafe:

a) FailSafe operation is factory disabled permanently.

b) FailSafe mode is enabled upon power-up, but FailSafe can be disabled via a command from the host.

c) FailSafe mode is disabled upon power-up, but FailSafe can be enabled via a command from the host.

d) FailSafe mode is always enabled, and cannot be disabled by host.

If option b, c, or d above is selected (i.e., FailSafe may be used at some time), the user must supply the following information:

a) FailSafe ID code (assigned by ARGOS, this ID Code may duplicate one of the ID Codes as specified above for standard operation, or it may be unique).

b) FailSafe Repetition Rate (assigned by ARGOS & corresponding to ID Code).

c) FailSafe time-out interval (1-255, minutes, hours, or days).

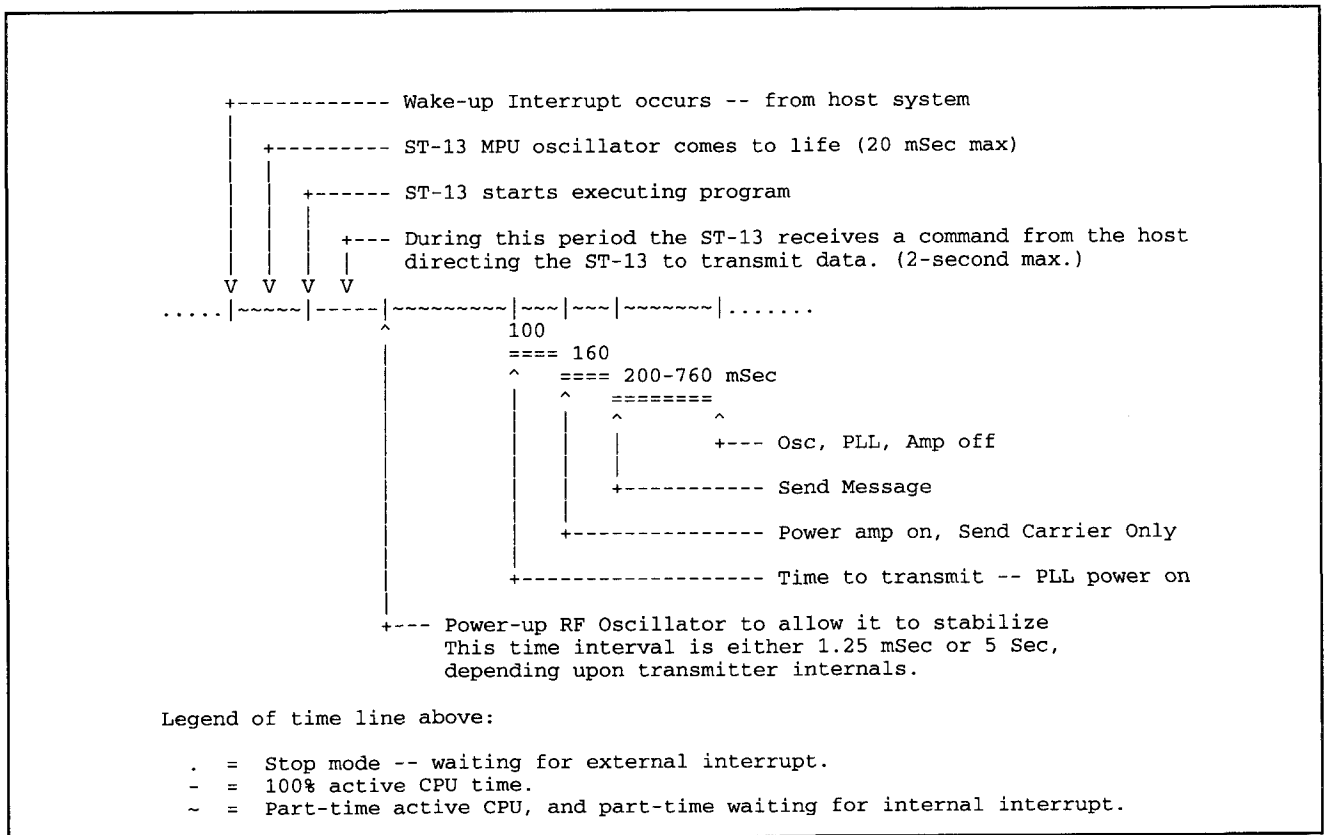
d) FailSafe message length (4,8,12,...28, or 32 bytes).

e) FailSafe message. The first 4 bytes are error codes. If the user wishes to send an additional message, up to 28 bytes may be specified. Please note that if this additional 28-byte message is to be utilized, the exact message must be specified at the time of purchase. These 28 bytes cannot be programmed or modified using TIPS.

f) FailSafe duty cycle. When the PTT is operating in FailSafe mode the time between transmissions is determined by the repetition rate. Transmissions can either occur continually (i.e. 24 hours per day), or a duty-cycle can be specified (e.g. 8 hours "on" / 16 hours "off"; 12 hours "on" / 12 hours "off," etc.).

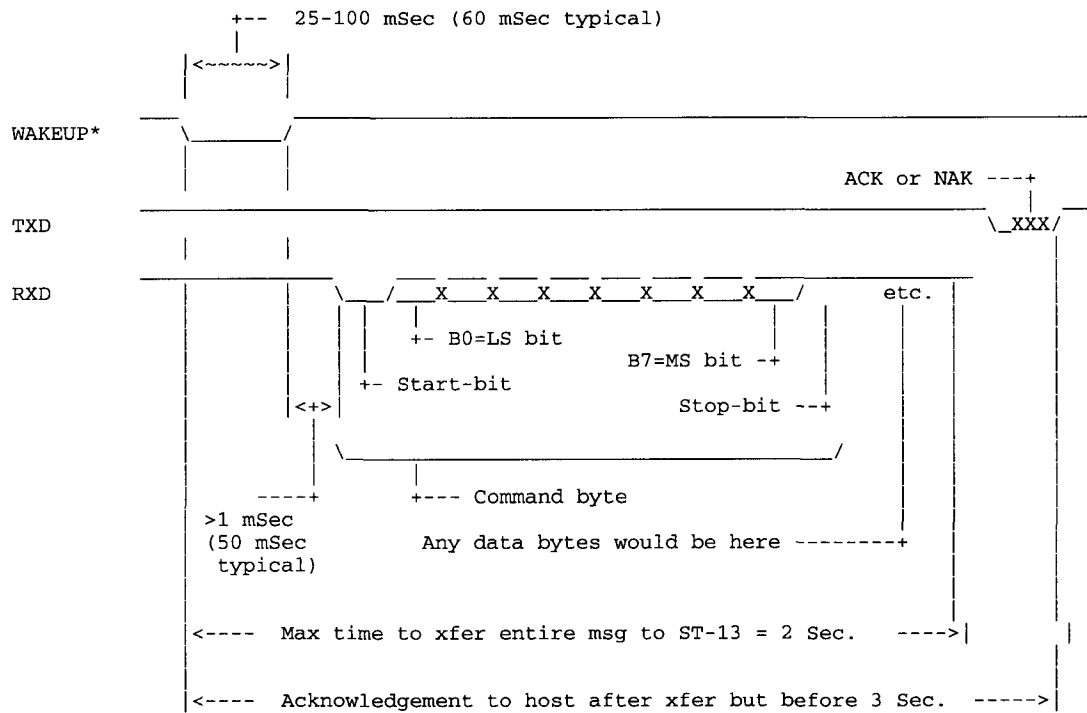
## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE

### A.11 TIMING DIAGRAMS



**FIGURE A-7. Transmission Timing Sequence**

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE



### Notes:

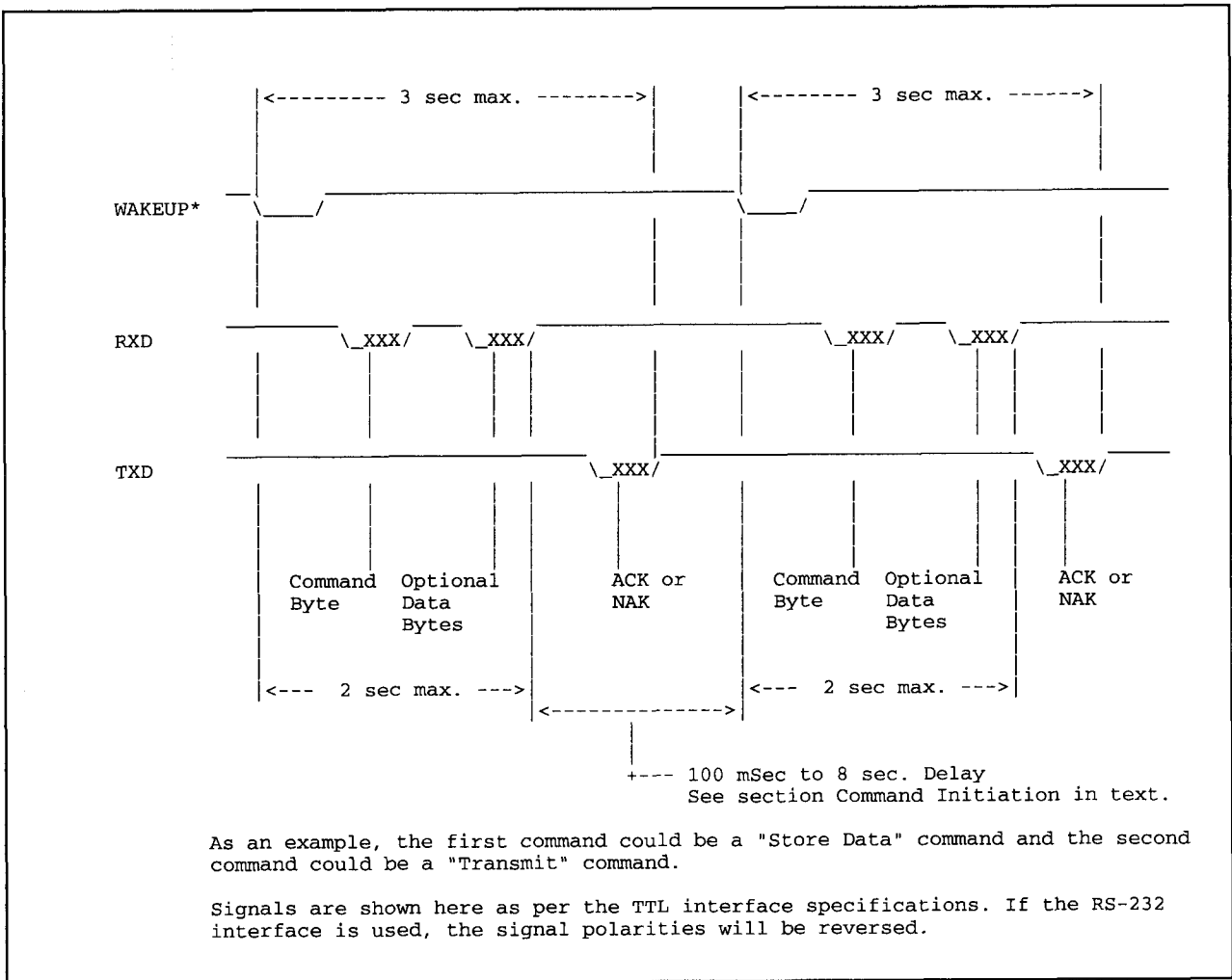
Data bits B0 - B7: 0 = low = 0 volts  
1 = high = 5 volts

The number of bytes supplied from host to ST-5 can vary from 1 to 33 during a single transfer operation.

Signals are shown here as per the TTL interface specifications. If the RS-232 interface is used, the signal polarities will be reversed.

**FIGURE A-8. Wakeup and Character Timing Characteristics**

## APPENDIX A. TELONICS ST-13 ASYNCHRONOUS SERIAL INTERFACE



**FIGURE A-9. Multiple Command Timing**





## APPENDIX B. FINAL STORAGE FORMAT

CR10X data is formatted as either 2 byte LO Resolution or 4 byte HI Resolution values. The first two bytes of an Output Array contain a unique code (FC Hex) noting the start of the Output Array and the Output Array ID, followed by the 2 or 4 byte data values. At the end of the data sent in response to the telecommunications F command a 2 byte signature is sent (see below).

Representing the bits in the first byte of each two byte pair as ABCD EFGH (A is the most significant bit, MSB), the byte pairs are described here.

### LO RESOLUTION FORMAT - D,E,F, NOT ALL ONES

<u>Bits</u>	<u>Description</u>
A	Polarity, 0 = +, 1 = -.
B, C	Decimal locators as defined below.
D-H plus second byte	13 bit binary value (D=MSB). Largest possible number without D, E, and F all 1 is 7167,
byte	but CSI defines the largest allowable range as 6999.

The decimal locators can be viewed as a negative base 10 exponent with decimal locations as follows:

<u>B</u>	<u>C</u>	<u>Decimal Location</u>
0	0	XXXX.
0	1	XXX.X
1	0	XX.XX
1	1	X.XXX

### DATA TYPE WHEN D,E,F, ALL EQUAL ONE

If D, E, and F are all ones, the data type is determined by the other bits as shown below. X implies a "don't care" condition; i.e., the bit can be either 1 or 0 and is not used in the decode decision.

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>DATA TYPE AND SECOND BYTE FORMAT</u>
1	1	1	1	1	1	X	X	A,B,C, = 1 - Start of Output Array, G & H are the most significant bits of the Output Array ID. All 8 bits of the 2nd byte are also included in the ID.
X	X	0	1	1	1	X	X	C = 0 - First byte of a 4 byte value.
0	0	1	1	1	1	X	X	A,B = 0; C = 1 - Third byte of a 4 byte value.
0	1	1	1	1	1	1	1	A = 0; remaining bits = 1 - First byte of a 2 byte "dummy" word. The CR10X always transmits a 0 for the 2nd byte, but the word can be decoded on the basis of the 1st byte only.

