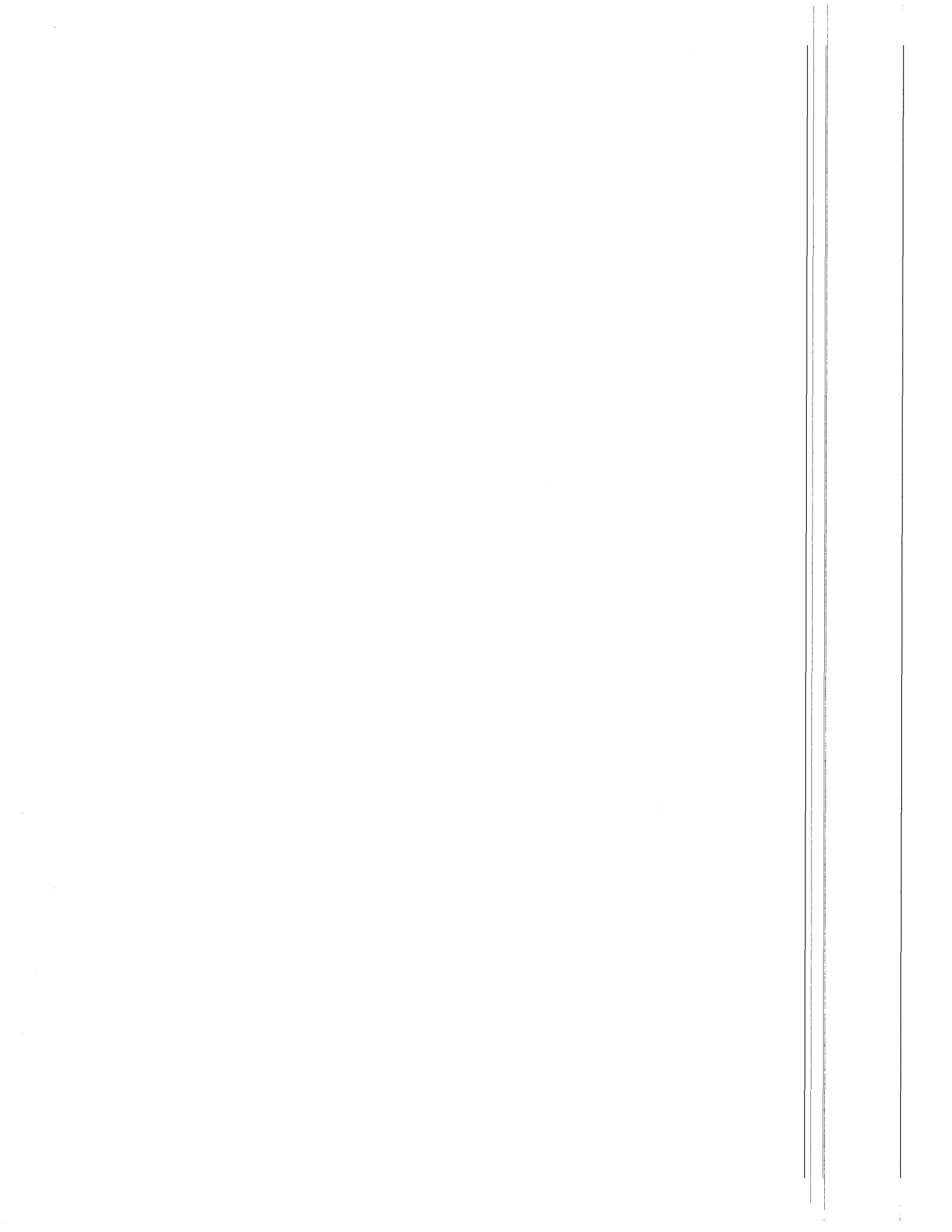


**ST-13 ARGOS SATELLITE TRANSMITTER
INSTRUCTION MANUAL**

4/99

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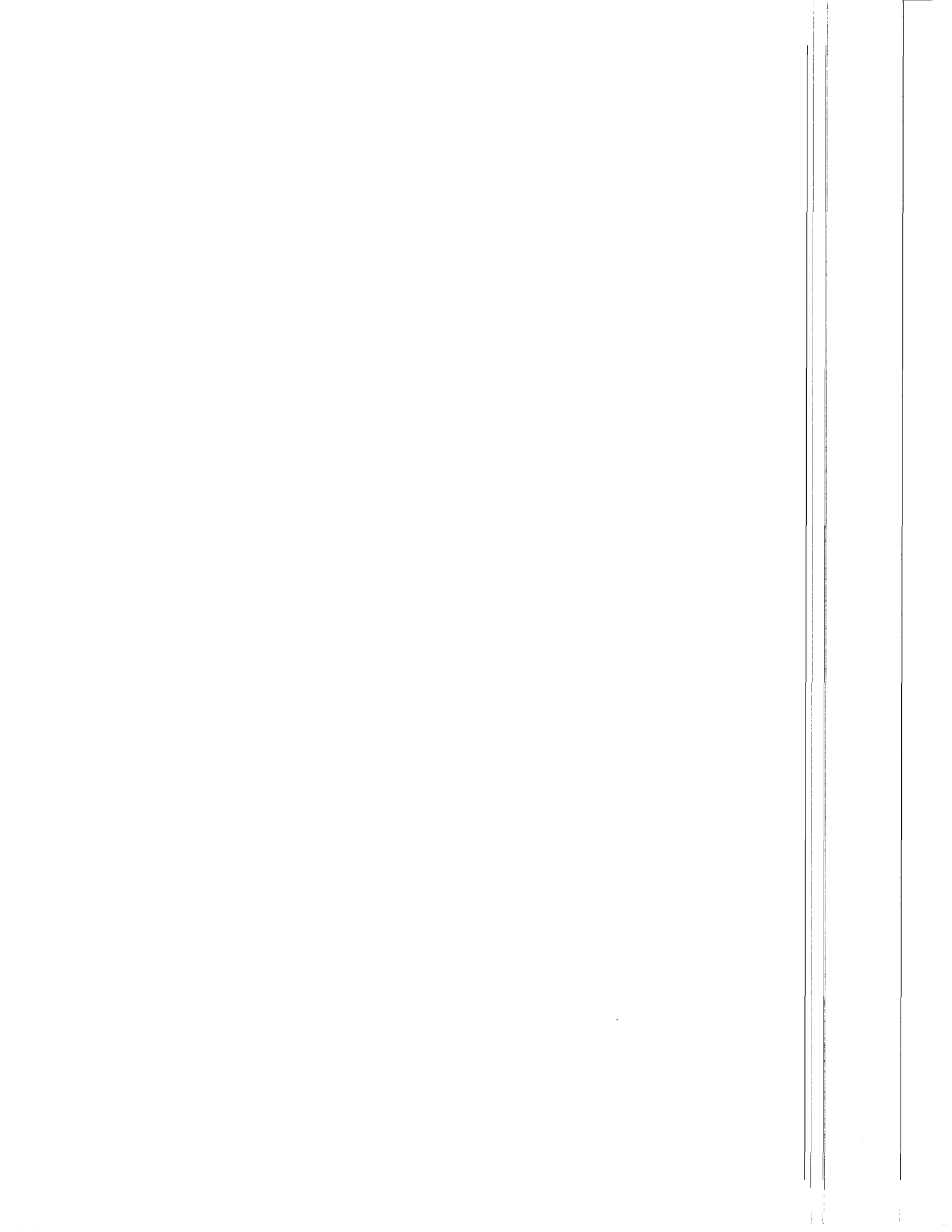


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ST-13 ARGOS SATELLITE TRANSMITTER

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ST-13 ARGOS SATELLITE TRANSMITTER

1. ARGOS OVERVIEW¹

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).

¹ From Argos User Manual 1.0 January 1996

ST-13 ARGOS SATELLITE TRANSMITTER

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 ±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**

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

- **For users in western North America**

Service Argos, Inc.
4210 198th St., S.W.
Suite 202
Lynwood, WA 98036
Tel: (+1) 206-672-4699
Fax: (+1) 206-672-8926
E-Mail: useroffice@argosinc.com

- **For users in Japan**

Cubic-I Ltd
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Nishi Gotanda
Shinagawa-ku
Tokyo 141
Japan
Tel: (+81) 3-3779-5506
Fax: (+81) 3-3779-5783
E-mail: useroffice@argos.cnes.fr (send via
Toulouse)

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

Bureau of Meteorology
GPO Box 1289 K
Melbourne, Victoria 3001
Australia
Tel: (+61) 3-9669-4650
Fax: (+61) 3-9669-4675
E-mail: clsargos@bom.gov.au

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

CLS
18 avenue Edouard-Belin
31055 Toulouse Cedex
France
Tel: (+33) (0)5-61-394-700
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

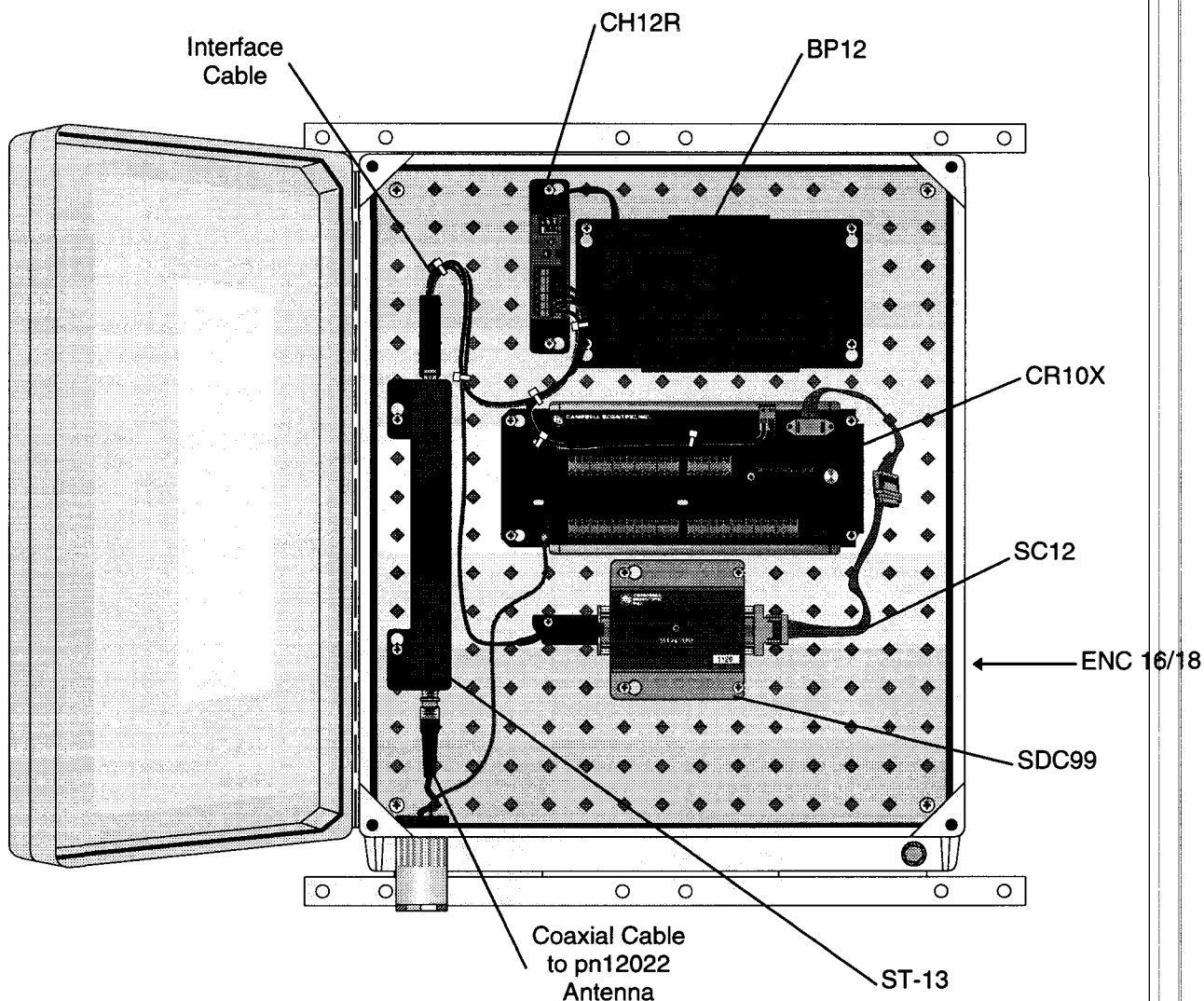


FIGURE 1. ST-13 Enclosure Assembly

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.

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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.

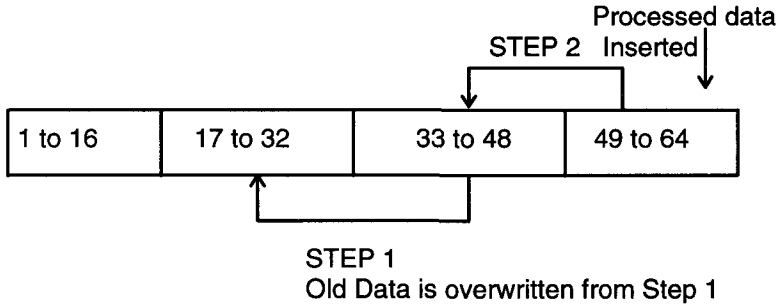
An attached programming example for the CR10(X) that provides the scenario for moving data block of 16 datapoints every 20 minutes, hence at minutes 20, 40 and 60, new data is sent and transmitted at 90 second (optional from ARGOS) intervals.

ST-13 ARGOS SATELLITE TRANSMITTER

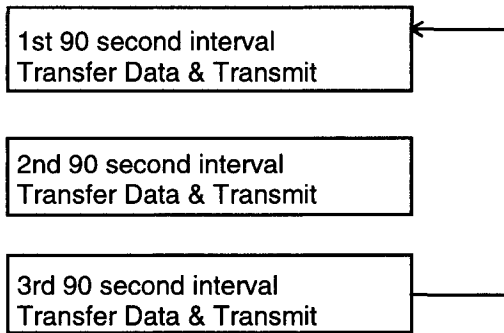
Theory Block Diagram

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 Repts
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 **

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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

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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 & 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, á(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

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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.
;
;

```
