Sagebrush Technology Inc.

Model-20 Pan & Tilt Gimbal

Firmware Documentation

Short and Long Command Sets

Operating System 4.xx

Pan / Tilt Version 4.xx

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Section 1 - Introduction to the Firmware Implementation

This document will give the reader the information required to write and customize an application that will interface to the Model 20 Pan/Tilt. This information includes a detailed description of the communication protocol, detailed descriptions of all commands and their appropriate uses, and the command structures and their responses. For the rest of this section, a basic description of how the firmware is structured and implemented will be presented. Greater details will be given in their respective sections.

Firmware Structure and Implementation

The firmware for the Model 20 Pan/Tilt is composed of two programs. The first program is the operating system that provides input/output services (serial communications) and program loading and execution for the Model 20. The second is the pan/tilt program which performs the operation of the stepper motors, lens control, auxiliary serial ports, etc. This program is referred to as the “download” program.

The operating system (OS) is an important part of the Model 20 firmware because it provides the Model 20 with a method to load and run new revisions or customized versions of “download” programs through serial communications. The OS also provides serial communications and command processing for the “download” program. Other features of the OS include power-up and failure history, total unit operational time, and a firmware serial number. The OS is loaded only once onto the Model 20 at the factory and remains in memory for the lifetime of the unit.

The “download” program (pan/tilt program) for the Model 20 provides the user with commands to control the motion of the stepper motors, control over a lens, and transmit and receive characters on two auxiliary serial ports within the Model 20. Any required alterations in the commands or functionality of the “download” program can be accomplished and easily loaded onto a Model 20 in the manner described below. This can be done oftentimes without returning the Model 20 to the manufacturer.

A new revision or customized “download” program is loaded via serial communications to the Model 20. This is done through a MS-DOS based program that asks for the serial port the Model 20 is attached to, and then passes the program data and other relevant information to the OS on the Model 20. When completed, the OS calculates and saves a CRC value of the program. Each time the Model 20 is then powered on, the validity of the “download” program is checked. If the CRC is valid, the OS passes control to the “download” program. If the CRC is incorrect, or a mishandled exception occurs in the “download” program, the OS regains control and continues to operate.

All serial communication and command processing is controlled by the operating system. Communication with the operating system or the “download” program begins through the sending of a serial command packet to the Model 20. When a serial command is received by the operating system, the following process occurs. First, the validity of the command packet is checked. If something is invalid within the packet, an error packet is returned. Second, the OS checks to see of the command is to be handled by the operating system. If it is, the action is performed and a response packet is returned. If the command is to be handled by the “download” program, the OS passes control to the appropriate routine in the “download” program that handles that command and returns a response packet when completed.

With the generic description of how the operating system and “download” program interact, the rest of this document will explain the details of these two programs.

Section 2 - Operating System Functionality

As mentioned earlier in this document, the operating system provides the method for the loading and execution of the pan/tilt firmware. The commands and their descriptions, which deal with this process, are not included in this document due to the possibility of program loss if used incorrectly. (This information is available upon request.) However, this section will discuss the retrieval of pertinent information about the operating system and the configuring of serial communications with the Model 20.

The operating system provides several commands for the retrieval of information about the operating system and the execution of the pan/tilt program. Two commands exist which instruct the Model 20 to return the version number of the operating system and the firmware serial number that is useful for inventory tracking.

Another command returns the execution state of the pan/tilt program. This is useful to determine if the operating system has determined the pan/tilt program to be acceptable to execute after boot-up.

Three more commands allow the user to setup and evaluate the communication parameters. Two of the three commands control the baud rate and the unique unit network address. The third returns a string of text that allows the controller software to detect the baud rate that the Model 20 is set to. Definitions of the commands come later in this document.

Some of the commands in the operating system require the passing of a parameter containing more than one byte. In command packets where this is the case, the most significant byte of the parameter must be transmitted first. Bytes must be continually transmitted in descending significance until the least significant byte of the parameter is transmitted. The Model 20 will transmit parameters larger than one byte, to the controller in the similar fashion.

Serial Communication Configurations

The operating system (OS) is controlled through a command/response communication method. The controller (user's system) sends a command to the Model 20 and then must wait for the response from the Model 20 before another command is requested. Often, the time a controller must wait between commands is the number of bits in the response multiplied by the baud rate. This is due to negligible latency between the time the Model 20 receives the command, executes the command, and then returns a response (approximately 450 µs as a worst case). Several "Reset" commands are the exception to this.

The Model 20 operating system supports multi-point networking of pan/tilts by giving the user the ability to assign an unique address to each unit on the network. The range of addresses is 1 to 255. Address 0 is reserved for "broadcasting" a command to all Model 20 units on a multi-point network. On a single connection between the Model 20 and a controller, the Model 20 can be set to address 0 since there are no other pan/tilts on the network. The rules each Model 20 follows for executing and responding to a command are described in greater detail in the following section.

Two serial communications protocols are supported by the electronics in a Model 20 pan/tilt. These protocols are RS-232 and RS-485 (half-duplex).

RS-232 can be used if only one Model 20 is attached to one serial communications port of the controller. Only three wires are required to operate a Model 20 pan/tilt using RS-232. These wires are transmit, receive, and ground. The serial communications port must be setup with the following parameters:

Baud Rate	1200, 2400,4800,9600,19200, or 38400 BPS
Parity	None
Data Bits	8 bits
Stop Bits	1 bit

RS-485 can be used with the Model 20 in half-duplex mode that uses only two wires. The communication parameters are the same as those used for RS-232 communications. Each Model 20 must have unique address, which should be set before placement on the network, unless there is only one Model 20 on the network. The user must be careful to properly terminate the network as required. It is imperative that the controller software receives all characters from the Model 20 on the network before a new command is issued or a collision of characters will occur.

Section 3 - Serial Communications

Command Packet Structure — From Controller to Model 20

The command packet structure is defined as either fixed or variable length depending upon the command desired.

Fixed length command packet

STX	Address	Command	Data 0	Data 1	Data 2 Ö Data N	CRC	ETX

Variable length command packet

STX	Address	Command	Size: N	Data 0	Data 1	Data 2 Ö Data N	CRC	ETX

Start of Text (STX) - The Start of Text byte informs the Model 20 to start processing a new command packet. The Model 20 will ignore all other bytes until the start of text byte is received. The Start of Text bytes always has a value of 0x02.

Address - The Model 20 compares the Address byte of the command packet to its assigned network address. The response is as follows:

- If the address byte is equal to the Model 20 network address and both are a non-zero number, the command is executed and a response packet sent.
- If the address byte is equal to the Model 20 network address and both are zero, the command is executed and a response packet sent.
- If the address byte is zero, and the Model 20 network address is a non-zero number, the command is executed only and no response packet is sent.

Command - The Model 20 checks the validity of the Command byte. If the Command byte is valid and the packet is correctly received, the command is executed and a response packet sent. If the Command byte is invalid or the packet is incorrectly received, the Model 20 will respond with an error packet but will not execute any command.

Size - The Size byte is required for a variable length command packet only. This indicates the number of data bytes in the packet.

Data - The Data bytes are the parameters or information required for the command to execute. If no data bytes are required for the command, the CRC byte will immediately follow the command byte.

CRC - This is low byte of a 16-bit CRC algorithm calculated for all previous bytes (Start of Text byte to the end of the Data bytes). If the CRC byte is incorrect, the command will not be executed. The CRC algorithm is derived from the polynomial x^16 + x^12 + x^5 + 1. The method for generating the CRC byte in the “C” language is shown later in this section.

End of Text (ETX) - This byte informs the Model 20 that the command packet is complete and always has a value of 0x03.

Response Packet Structure — From Model 20 to Controller

The command packet structure is defined as either fixed or variable length depending upon the command desired and the validity of the received command packet.

Error response packet

STX	Address	Error	CRC	ETX

Fixed length response packet

STX	Address	Error = 0	Data 0	Data 1	Data 2ÖData N	CRC	ETX

Variable length response packet

STX	Address	Error = 0	Size: N	Data 1	Data 2ÖData N	CRC	ETX

Start of Text (STX) - Informs the controller that a response packet is being sent and always has a value of 0x02.

Address - Informs the controller of the Model 20's network address.

Error - The Error byte informs the controller if a command packet error has occurred. If the Error is zero, the command packet was correctly received and executed and the data bytes will be included in the response packet. If the Error is not zero, the command packet was incorrectly received and the CRC and ETX bytes will follow. The Error is returned with the appropriate bits set representing the error as shown below:

bit 0	reserved - always 0
bit 1	Incorrect CRC byte
bit 2	Invalid Command
bit 3	Incorrect Frame
bit 4	reserved - always 0
bit 5	reserved - always 0
bit 6	reserved - always 0
bit 7	reserved - always 0

Size - The Size byte is required for a variable length response packet only. This indicates the number of data bytes in the response packet.

Data - The Data bytes return any information associated with the command requested. If no data bytes are required in the response, the CRC byte will immediately follow the error byte.

CRC - This is the low byte of a 16-bit CRC algorithm calculated for all previous bytes. It is calculated in the same manner as the command packet CRC byte. An example is shown later in this section.

End of Text (ETX) - This informs the controller that the response packet is complete and always has a value of 0x03.

CRC Generation for Command and Response Packets

The following example in the “C” language demonstrates how to generate the CRC value for a packet. The parameter: pPacket represents the array of packet characters. The parameter: nSize, represents the number of bytes from the Start of Text byte to the end of the data bytes (all the bytes before the CRC byte). For example, the packet below contains 4 characters before the CRC byte. Therefore, nSize = 4. (This packet is a valid command packet and can be used to test the user’s implementation of the CRC algorithm. This command sets the baud rate of the operating system to 19200 BPS.)

STX	Address	Command	Data	CRC	ETX
0x02	0x00	0x0A	0x06	0x30	0x03

The function below returns the correct CRC value.

```
char CRCGenerate(char *pPacket, int nSize)
{

    int nPacketOffset;
    long lCRCValue = 0;

     for(nPacketOffset = 0; nPacketOffset < nSize; nPacketOffset++)
     {
          lCRCValue = (lCRCValue >> 4) ^ (((lCRCValue ^ pPacket[nPacketOffset]) & 0x0F) * 0x1081);
          lCRCValue = (lCRCValue >> 4) ^ (((lCRCValue ^ (pPacket[nPacketOffset]>>4)) & 0x0F) * 0x1081);
     }
     return (char) (lCRCValue & 0x000000FF);
}
```

The value returned becomes the CRC byte of a command packet. For a response packet, the value gets compared to the CRC byte to test the validity of the packet.

Section 4 - Operating System Commands

The first five commands in this section pertain to obtaining information about the operating system. These include obtaining an operating system version number, a firmware serial number, the execution state of the pan/tilt firmware, the total time of operation, and an event history log. The last three commands in this section involve the setting of communication parameters such as the baud rate and the network address of the operating system.

Operating System Version — Returns the version string of the operating system. The string is in the form: "POS 4.XX", or similar. The size of the string returned may vary slightly with different revisions.

Command Packet

STX	Address	0x00	CRC	ETX

Response Packet (Variable Length)

STX	Address	Error	Size	Version String *("Size" bytes)*	CRC	ETX

Operating System Information — Returns the network **Address** and **Serial Number** of the pan/tilt. **Valid SN** returns a value of one if the Model 20 firmware has been assigned a **Serial Number**. If **Valid SN** returns a zero, the **Serial Number** returned will not be valid. **Serial Number** is a fixed-size (10 bytes) array containing the operating system firmware identification. (The redundant **Address** byte exists for easier interface programming.)

Command Packet

STX	Address	0x0E	CRC	ETX

Response Packet

STX	Address	Error	Address	Valid SN	Serial Number *(10 bytes)*	CRC	ETX

Operating System State — Returns the execution state of the pan/tilt firmware. If **State** has a value of zero, a new "download" program needs to be loaded.

Command Packet

STX	Address	0x01	CRC	ETX

Response Packet

STX	Address	Error	State	CRC	ETX

State returns the following:

State = 0	Pan/tilt firmware is not executing
State = 1	Pan/tilt firmware is executing

Total Operating Time — Returns the total time the Model 20 has been powered on. **Minutes** contains a value between 0 and 16,777,216 (almost 32 years). The most significant byte is transmitted first. **Seconds** contains a value between 0 - 59.

Command Packet

STX	Address	0x02	CRC	ETX

Response Packet

STX	Address	Error	Minutes *(3 bytes)*	Seconds	CRC	ETX

Event History — Returns the event information and the time associated with the **Event Number**. An event is defined as a reboot, a mishandled exception, or any other cause of error processing. **Event Number** should be a value between 0 and 4. In the response packet, **Minutes** contains a value between 0 and 16,777,216. The most significant byte is transmitted first. **Seconds** contains a value between 0 - 59. **Event Type** has a value of zero if no event is recorded for the desired **Event Number**. If the **Event Type** contains a value of one, the Model 20 has rebooted and **Event Information** contains one of the following values:

2	CPU Reset Instruction
4	Loss of Clock Reset
16	Double Bus Fault
32	Watchdog
64	Power-On Reset
128	External Reset

If the **Event Type** contains a value of two, an exception has been mishandled or an error has occurred. In this case, **Event Information** contains the number of the exception or error. This event is used as a troubleshooting tool when developing a new “download” program and should never be encountered during normal operation. Detailed information about exceptions is beyond the scope of this document. If an **Event Number** is not valid, **Status** returns as a non-zero number.

Command Packet

STX	Address	0x03	Event Number	CRC	ETX

Response Packet

STX	Address	Error	Status	Minutes *(3 bytes)*	Seconds

Event Type	Event Information	CRC	ETX

Set Operating System Baud Rate — Sets the baud rate of the Model 20 operating system to one of the following values:

Rate = 2	1200 BPS
Rate = 3	2400 BPS
Rate = 4	4800 BPS
Rate = 5	9600 BPS
Rate = 6	19200 BPS
Rate = 7	38400 BPS
Rate = 8	57600 BPS

NOTE: The baud rate of the Model 20 is set immediately after receiving this command and no response packet is replied. If **Rate** does not contain a value between 2 and 7, **Status** is set to two and the response packet is transmitted.

Command Packet

STX	Address	0x0A	Rate	CRC	ETX

Response Packet (See Note Above)

STX	Address	Error	Status	CRC	ETX

Set Operating System Address — Assigns the network address of the Model 20.

NOTE: The **New Network Address** of the pan/tilt is assigned after receiving this command and no response packet is replied. From that point on, the **New Network Address** must be used as the **Address** in the command packet of all future commands.

Command Packet

STX	Address	0x0B	New Network Address	CRC	ETX

Check Operating System Baud Rate — Returns a packet containing the word: BAUD (all capital letters). Automatic baud detection can be performed by using this command and verifying the packet came back correctly.

Command Packet

STX	Address	0x0D	CRC	ETX

Response Packet

STX	Address	Error	B	A	U	D	CRC	ETX

Section 5 - Pan/Tilt Firmware Functionality

The Model 20 Pan/Tilt Firmware controls three separate functions of the pan/tilt that will be described in this section. The first is stepping control over the motors of the azimuth and elevation axis. The second function controlled by the firmware is the positioning of the zoom and focus components of a lens. The third is the function of transmitting and receiving characters through two auxiliary serial ports.

Many of the commands in the pan/tilt firmware required the passing of two or four byte parameters. In all command packets where a parameter is specified larger than one byte, the most significant byte must be transmitted first. Bytes must be continually transmitted in descending significance until the least significant byte of the parameter is transmitted. The Model 20 will transmit parameters larger than one byte to the controller in the similar fashion.

Stepping Control of the Azimuth and Elevation Motors

The Model 20 firmware provides support for a wide range of stepper motors by providing a “short” command set and a “long” command set. The “short” command set can be used when the extent of travel for both azimuth and elevation is less than 65,536 steps. The advantage to using the “short”

command set is that the command and response communication packets require fewer characters. The “long” command set should be used when the extent of travel for azimuth and elevation exceeds 65,536 steps. A command is provided to allow the user to choose which command set is required. The choice of command set is maintained in persistent memory. The “short” command set is the factory default.

The Model 20 firmware also provides a choice of four coordinate systems. A coordinate system is a method by which a user can describe the position of azimuth and elevation. This is useful if the user wanted to maintain the same orientation of direction and position even though the Model 20 is mounted sideways on a wall or mounted upside down on a ceiling. The factory default is a tabletop mounting. In this coordinate system, azimuth is the base of the Model 20 and travels clockwise in a positive direction. Elevation is the head of the Model 20 with the front of the mounting cradle moving upward in a positive direction. A command is provided to choose the coordinate system that remains persistent in memory.

The pan/tilt firmware gives the user a large amount of control over the configuration of power and motion characteristics of each motor. Power configuration options include specifying current through and voltage applied to each motor for the entire range of step rates. Motion configuration options include specifying the maximum step rate, the starting step rate, and an acceleration parameter.

Power can be configured for each independent axis. Current values are specified for a set of step rates (including a holding state) to form a “current curve” which is used by the Model 20 to determine the current required for a desired step rate. Voltage is configured by specifying step rates when the Model 20 is to apply 5, 12, or the supplied voltage to the motors. Holding voltage is always 12 volts.

The motion characteristics of the Model 20 can be configured for each independent axis also. These characteristics directly effect how a s-curve motion is implemented on every move or change in motion. The parameters include the maximum step rate, the starting step rate, and the acceleration parameter.

The Model 20 implements a s-curve motion based on the desired speed, distance of travel, and acceleration desired. The starting step rate (or start rate) is the beginning of the s-curve calculation for the Model 20. If the desired step rate is lower than this starting step rate, no s-curve motion is performed. Instead, the Model 20 begins movement at the desired step rate. However, if the desired step rate is above the starting step rate (or start rate), motion of the Model 20 begins at the start rate and increases in the form of an s-curve until the desired step rate is achieved. When it is time for the Model 20 to decelerate, motion is decreased in the form of a s-curve until the desired position is reached and the step rate is equal to the start rate. A special condition occurs in the s-curve calculation when there is not enough steps between the starting position and the ending position to achieve the desired step rate. In this case, the Model 20 accelerates (in the form of an s-curve) for one-fourth of the distance to be traveled, remains at the intermediate step rate for one-half of the distance, and then decelerates (in the form of an s-curve) for the remaining one-fourth of the distance to be traveled. An acceleration parameter is provided so the user can dictate the rate of acceleration. This parameter represents a ratio to the Model 20 for calculating the number of steps required to accelerate from the start rate to the slew rate. It is directly proportional to the actual acceleration. The lower the acceleration parameter, the lower the acceleration, and the higher number of steps are required to reach the desired step rate. The higher the acceleration parameter, the higher the acceleration, and a lower number of steps are required to reach the desired step rate.

The pan/tilt firmware also gives the user many options for motion and positioning. A motion command moves each axis at a desired step rate. This command is useful for manual control of the Model 20 by a joystick or touchscreen. Positioning commands allow the user to specify the step location for each motor. (The Model 20 moves each axis in a manner that both axis arrive at the desired location at nearly the same instant.) These commands are useful when precise positioning is required. For more detailed information, see section 9 on pan/tilt movement commands.

The Model 20 also implements presets that can be used to store repeated locations (azimuth, elevation, zoom, and focus) within the Model 20’s persistent memory. Any preset can be stored to the current position of the Model 20 or by specifying the position in a command packet. Any preset can be recalled at any time. The user may also upload or download a block of ten presets for saving to and restoring from the controller.

For low power applications, the Model 20 implements low power and sleep modes. In the low power mode, power to the stepper motors is removed. Any subsequent move command is acknowledged but

no motion takes place. When low power mode is exited, power is reapplied to the motors. Low power mode can be entered and exited through the use of two commands. Another command is available for sleep mode that also removes power to the stepper motors. However, sleep mode stops all clocks to the processor of the Model 20. No commands will be acknowledged by the Model 20. To exit sleep mode, the two pins of J8 on the CPU card of the Model 20 must be shorted together. When this occurs, the Model 20 resumes normal operation.

Three reference switches per axis are implemented on the Model 20 to assure the correct positioning of both azimuth and elevation. The are two extent switches and a center reference switch. The two extent switches limit the range of travel for each axis. The center reference switch is used to monitor the position of the axis. This is done by keeping track of the positions which the center reference switch closes; one position for each direction. If the axis is incorrectly positioned and the center reference switch is encountered during the course of motion, the position of that axis is corrected after all motion is completed. If an extent switch is encountered, the axis will search for the center reference switch, correct itself, and then return to the correct desired position.

The Model 20 provides two calibration commands. These commands are the “recalibrate” and the “verify position” commands. The “recalibrate” command moves both the head and the base of the Model 20 through all the reference switches and records these positions. Azimuth and elevation are constantly monitored for positional errors based on these recorded positions (as described in the previous paragraph). The “verify position” command moves either the head or base of the Model 20 into their respective center reference switches and then returns each axis to its previous location.

Zoom and Focus Positioning

The Model 20 firmware provides support for controlling the zoom and focus components of a lens. Each motor (zoom and focus) in the lens is powered by two pulsewidth modulated 12 volt signals which control the rate and direction of lens movement. The Model 20 keeps track of position of each motor through the use of two 10-bit analog-to-digital converters.

Zoom and Focus can be controlled by the use of motion or positioning commands. A motion command is provided to move zoom and focus either direction at one of three different rates. This command is useful for a joystick or touchscreen application. A position command is provided for the user to specify the exact location which zoom and focus will be set to. The position is specified in increments of the analog-to-digital converter counts, which correspond to the voltage read from the feedback potentiometers inside the lens. For more detailed information about these commands, see section 9 on pan/tilt movement commands.

The Model 20 provides a large number of configuration options to the user. However, before any of these configurations can be discussed, it is necessary to convey how the Model 20 moves zoom and/or focus to a new position. After the Model 20 receives a lens position command, the lens is driven in the direction of the desired position at the fastest rate (rate 3). Once the lens is within a defined number of steps (or analog-to-digital counts) of the desired position, the rate of motion slows to the slowest rate (rate 1). This “slow-down” window is user-specified and allows for a smooth stopping of the lens. When the lens position is at the desired position, the lens direction is reversed and the pulsewidth is divided by a user-defined percentage. This decreases the amount of overshoot. The Model 20 firmware continues to oscillate in direction and divide the previous pulsewidth until the lens is no longer in motion. This assures a fairly high degree of accuracy in the position of the lens. The Model 20 firmware also incorporates a safety feature to protect the lens motors. If a lens motor is being driven but is not moving (i.e. at one extent of the lens rotation), the firmware will remove power to the motor after a user-defined period of time.

Due to the variation of lenses available, the Model 20 firmware provides complete configuration control over the motion of zoom and focus mentioned in the previous paragraph. These parameters are:

14. The frequency of the signal driving the lens motor
15. The pulsewidth corresponding to the three rates of lens motion.
16. The size of the “slow-down” window.
17. The decay value of pulsewidth after the lens has reached the desired position.
18. The time-out value in which power will be removed from the motor when not in motion.

When using the lens configuration commands, the parameters discussed earlier are in the following units. The frequency of the signal is specified in Hertz. Pulsewidth for the three rates of lens motion as well

as the decay value are specified as a percentage (0-100). The “slow-down” window is specified in the analog-to-digital counts (or steps). Finally, the time-out value is in units of 1/100th of a second.

Auxiliary Serial Ports

The Model 20 firmware provides two serial ports. These serial ports use three wires (transmit, receive, and ground) and can be used for control over other devices in the user’s application (such as encoders). Both serial ports are independent of each other and are interrupt driven within the Model 20 firmware. This assures that no characters will be lost in transmission and reception.

The user can easily control the communications for each port. The available commands allow the user to configure the serial port, transmit a string of characters, retrieve the characters in the receive buffer, check the number of characters in the receive buffer, and flush the receive buffer. The size of both the transmit and receive buffers for both ports are fixed at 100 bytes.

When configuring the serial port, the user can specify the baud rate, parity, and the number of data bytes. Baud rates supported include 1200, 2400, 4800, 9600, and 19200 BPS. Even, odd, or no parity as well as seven to eight data bits can be specified.

Section 6 - Configuration and Information Commands

The Model 20 Pan/Tilt Firmware provides commands to control all facets of pan/tilt operation. These commands include control over motor setup and power parameters and lens parameters. Other commands include setting the command set and coordinate system and reading the version number of the pan/tilt firmware.

Pan/Tilt Firmware Version — Returns the version string of the pan/tilt firmware. The size of the string returned may vary slightly with different revisions.

Command Packet

STX	Address	0x40	CRC	ETX

Response Packet (Variable Length)

STX	Address	Error	Size	Version String *("Size" bytes)*	CRC	ETX

Command Sets

The Model 20 provides support for a wide range of stepper motors by providing a "short" command set and a "long" command set. The "short" command set can be used when the extent of travel for both azimuth and elevation is less than 65,536 steps. The advantage to using the "short" command set is that the command and response communication packets require fewer characters. The "long" command set should be used when the extent of travel for azimuth and elevation exceeds 65,536 steps. A command is provided to allow the user to choose which command set is required.

Get Command Set in Use — Returns which command set in is use by the Model 20.

Command Packet

STX	Address	0x81	CRC	ETX

Response Packet

STX	Address	Error	Command Set	CRC	ETX

The command set parameter returns on of the following values:

command set = 0	short command set
command set = 1	long command set

Set Command Set — Sets the new command set the Model 20 will use. The command set parameter should be set to one of the following values:

command set = 0	short command set
command set = 1	long command set

Command Packet

STX	Address	0x82	Command Set	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Coordinate System

The next two commands pertain to the coordinate system the Model 20 uses. A coordinate system is a method by which a user can describe the position of azimuth and elevation. This is useful if the user wants to maintain the same orientation of direction and position even though the Model 20 is mounted sideways on a wall or mounted upside down on a ceiling. The factory default is the tabletop mounting and the coordinate system parameter is equal to zero. In this system, azimuth is the base of the Model 20 and travels clockwise in a positive direction. Elevation is the head of the Model 20 with the front of the mounting cradle moving upward in a positive direction. Two bits of the coordinate system parameter determine which system is in use. If bit zero is set, the orientation of the coordinates are reverse from the standard. The base of the Model 20 (azimuth) moves counter-clockwise for positive motion and elevation moves front-end downward. If bit two is set, the base of the Model 20 represents elevation and the head represents azimuth.

Get Coordinate System in Use — Returns which coordinate system in use by the Model 20.

Command Packet

STX	Address	0x80	CRC	ETX

Response Packet

STX	Address	Error	Coordinate System	CRC	ETX

The coordinate system parameter returns the following information:

bit 0	reverse orientation of each axis
bit 1	reserved
bit 2	reverse azimuth and elevation values
bit 3 - 7	reserved

Set Coordinate System — Sets the new coordinate system the Model 20 will use. Set bits zero and two of the coordinate system parameter for the appropriate application.

bit 0	reverse orientation of each axis
bit 1	reserved
bit 2	reverse azimuth and elevation values
bit 3 - 7	reserved

Command Packet

STX	Address	0x3F	Coordinate System	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Motion Parameters

The motion parameters directly effect how a s-curve motion is implemented on every move or change in motion. The parameters include the maximum step rate, the starting step rate, and the acceleration parameter. The starting step rate (or start rate) is the beginning of the s-curve calculation for the Model 20. If the desired step rate is lower than this starting step rate, no s-curve motion is performed. Instead, the Model 20 begins movement at the desired step rate. However, if the desired step rate is above the starting step rate (or start rate), motion of the Model 20 begins at the start rate and increases in the form of an s-curve until the desired step rate is achieved. When it is time for the Model 20 to decelerate, motion is decreased in the form of a s-curve until the desired position is reached and the step rate is equal to the start rate.

A special condition occurs in the s-curve calculation when there is not enough steps between the starting position and the ending position to achieve the desired step rate. In this case, the Model 20 accelerates (in the form of an s-curve) for one-fourth of the distance to be traveled, remains at the intermediate step rate for one-half of the distance, and then decelerates (in the form of an s-curve) for the remaining one-fourth of the distance to be traveled.

An acceleration parameter is provided so the user can dictate the rate of acceleration. This parameter represents a ratio to the Model 20 for calculating the number of steps required to accelerate from the start rate to the slew rate. It is directly proportional to the actual acceleration. The lower the acceleration parameter, the lower the acceleration, and the higher number of steps are required to reach the desired step rate. The higher the acceleration parameter, the higher the acceleration, and a lower number of steps are required to reach the desired step rate.

The last parameter in the following commands is a power time-out parameter, which determines the amount of time power remains applied to the motors after motion is stopped. This keeps each axis from overshooting the required position due to inertial forces.

The following commands refer to the base and the head of the Model 20 and not azimuth or elevation. These commands are not effected by the coordinate system.

Get Base Motor Configuration — Returns the motor configuration parameters for the base of the Model 20. Maximum step rate and start rate are specified in steps per second. Acceleration ratio is unit-less (see earlier discussion). Power time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x8C	CRC	ETX

Response Packet

STX	Address	Error	Maximum Step Rate *(2 bytes)*	Start Rate *(2 bytes)*

Acceleration *(2 bytes)*	Power Time-out *(2 bytes)*	CRC	ETX

Set Base Motor Configuration — Sets the motor configuration parameters for the base of the Model 20. Maximum step rate and start rate are specified in steps per second. Acceleration ratio is unit-less (see earlier discussion). Power time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x8D	Maximum Step Rate *(2 bytes)*	Start Rate *(2 bytes)*

Acceleration *(2 bytes)*	Power Time-out *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Set Base Maximum Step Rate — Sets the base maximum step rate. Maximum step rate is specified in steps per second.

Command Packet

STX	Address	0x8E	Maximum Step Rate *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Get Head Motor Configuration — Returns the motor configuration parameters for the head of the Model 20. Maximum step rate and start rate are specified in steps per second. Acceleration ratio is unit-less (see earlier discussion). Power time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x8F	CRC	ETX

Response Packet

STX	Address	Error	Maximum Step Rate *(2 bytes)*	Start Rate *(2 bytes)*

Acceleration *(2 bytes)*	Power Time-out *(2 bytes)*	CRC	ETX

Set Head Motor Configuration — Sets the motor configuration parameters for the head of the Model 20. Maximum step rate and start rate are specified in steps per second. Acceleration ratio is unit-less (see earlier discussion). Power time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x90	Maximum Step Rate *(2 bytes)*	Start Rate *(2 bytes)*

Acceleration *(2 bytes)*	Power Time-out *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Set Head Maximum Step Rate — Sets the head maximum step rate. Maximum step rate is specified in steps per second.

Command Packet

STX	Address	0x91	Maximum Step Rate *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Power Parameters

When the Model 20 is in motion, power is applied to the azimuth and elevation motors based on step rate and user defined parameters. Current values are specified for a set of step rates (including a holding state) to form a "current curve" which is used by the Model 20 to determine the current required for a desired step rate. Voltage is configured by specifying step rates when the Model 20 is to apply 5, 12, or the supplied voltage to the motors. Holding voltage is always 12 volts.

Current parameters are specified for the following: holding (no motion), 1 step/s, 100, 200, 400, 700, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 6000, 7000 and above 7000 steps/s. The current parameters are set values between 0 and 4096 and have the following relationship to the current through the motors:

Motor Current = (Current Parameter) / (1000 * Sense Resistor)

The Sense Resistor is 0.68 ohms on the standard Model 20 board set.

Voltage is configured by specifying two step rates that determine where the different voltage levels will be applied. The first step rate is point where the 5 volt range ends and the 12 volt range begins. The second step rate is the point the 12 volt range ends and the supply voltage begins.

Get Base Power Configuration — Returns the base power configuration.

Command Packet

STX	Address	0x92	CRC	ETX

Response Packet

STX	Address	Error	Holding Current *(2 bytes)*	Current - 1 step/s *(2 bytes)*

Current - 100 step/s *(2 bytes)*	Current - 200 step/s *(2 bytes)*	Current - 400 step/s *(2 bytes)*

Current - 700 step/s *(2 bytes)*	Current - 1000 step/s *(2 bytes)*	Current - 1500 step/s *(2 bytes)*

Current - 2000 step/s *(2 bytes)*	Current - 2500 step/s *(2 bytes)*	Current - 3000 step/s *(2 bytes)*

Current - 4000 step/s *(2 bytes)*	Current - 5000 step/s *(2 bytes)*	Current - 6000 step/s *(2 bytes)*

Current - 7000 step/s *(2 bytes)*	Current - > 7000 step/s *(2 bytes)*

Voltage - 5 to 12 V Step Rate *(2 bytes)*	Voltage - 12 to Supply V Step Rate *(2 bytes)*

CRC	ETX

Set Base Power Configuration — Sets the base power configuration.

Command Packet

STX	Address	0x93	Holding Current *(2 bytes)*	Current - 1 step/s *(2 bytes)*

Current - 100 step/s *(2 bytes)*	Current - 200 step/s *(2 bytes)*	Current - 400 step/s *(2 bytes)*

Current - 700 step/s *(2 bytes)*	Current - 1000 step/s *(2 bytes)*	Current - 1500 step/s *(2 bytes)*

Current - 2000 step/s *(2 bytes)*	Current - 2500 step/s *(2 bytes)*	Current - 3000 step/s *(2 bytes)*

Current - 4000 step/s *(2 bytes)*	Current - 5000 step/s *(2 bytes)*	Current - 6000 step/s *(2 bytes)*

Current - 7000 step/s *(2 bytes)*	Current - > 7000 step/s *(2 bytes)*

Voltage - 5 to 12 V Step Rate *(2 bytes)*	Voltage - 12 to Supply V Step Rate *(2 bytes)*

CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Get Head Power Configuration — Returns the head power configuration.

Command Packet

STX	Address	0x94	CRC	ETX

Response Packet

STX	Address	Error	Holding Current *(2 bytes)*	Current - 1 step/s *(2 bytes)*

Current - 100 step/s *(2 bytes)*	Current - 200 step/s *(2 bytes)*	Current - 400 step/s *(2 bytes)*

Current - 700 step/s *(2 bytes)*	Current - 1000 step/s *(2 bytes)*	Current - 1500 step/s *(2 bytes)*

Current - 2000 step/s *(2 bytes)*	Current - 2500 step/s *(2 bytes)*	Current - 3000 step/s *(2 bytes)*

Current - 4000 step/s *(2 bytes)*	Current - 5000 step/s *(2 bytes)*	Current - 6000 step/s *(2 bytes)*

Current - 7000 step/s *(2 bytes)*	Current - > 7000 step/s *(2 bytes)*

Voltage - 5 to 12 V Step Rate *(2 bytes)*	Voltage - 12 to Supply V Step Rate *(2 bytes)*

CRC	ETX

Set Head Power Configuration — Sets the head power configuration.

Command Packet

STX	Address	0x95	Holding Current *(2 bytes)*	Current - 1 step/s *(2 bytes)*

Current - 100 step/s *(2 bytes)*	Current - 200 step/s *(2 bytes)*	Current - 400 step/s *(2 bytes)*

Current - 700 step/s *(2 bytes)*	Current - 1000 step/s *(2 bytes)*	Current - 1500 step/s *(2 bytes)*

Current - 2000 step/s *(2 bytes)*	Current - 2500 step/s *(2 bytes)*	Current - 3000 step/s *(2 bytes)*

Current - 4000 step/s *(2 bytes)*	Current - 5000 step/s *(2 bytes)*	Current - 6000 step/s *(2 bytes)*

Current - 7000 step/s *(2 bytes)*	Current - > 7000 step/s *(2 bytes)*

Voltage - 5 to 12 V Step Rate *(2 bytes)*	Voltage - 12 to Supply V Step Rate *(2 bytes)*

CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Lens Parameters

The Model 20 uses a modulated motor drive and an analog-to-digital converter to control zoom and focus. Each motor (zoom and focus) in the lens is powered by two pulsewidth modulated 12 volt motor drive signals which control the rate and direction of lens movement. Through the use of two 10-bit analog-to-digital converters, the Model 20 tracks the position of each motor.

The Model 20 performs the following actions when moving the lens. After a lens position command is received, the lens is driven in the direction of the desired position at the fastest rate (rate 3). Once the lens is within a defined number of steps (or analog-to-digital counts) of the desired position, the rate of motion slows to the slowest rate (rate 1). This “slow-down” window is user-specified and allows for a smooth stopping of the lens. When the lens position is at the desired position, the lens direction is reversed and the pulsewidth is divided by a user-defined percentage. This decreases the amount of overshoot. The Model 20 firmware continues to oscillate in direction and divide the previous pulsewidth until the lens is no longer in motion. This assures a fairly high degree of accuracy in the position of the lens. The Model 20 firmware also incorporates a safety feature to protect the lens motors. If a lens motor is being driven but is not moving (i.e. at one extent of the lens rotation), the firmware will remove power to the motor after a user-defined period of time. To summarize, user-defined parameters for the lens include:

19. The frequency of the signal driving the lens motor
20. The pulsewidth corresponding to the three rates of lens motion.
21. The decay value of pulsewidth after the lens has reached the desired position.
22. The size of the “slow-down” window.
23. The time-out value in which power will be removed from the motor when not in motion.

Get Zoom Configuration — Returns the zoom configuration. Drive frequency is in Hertz. Low, medium, and high rate duty cycles as well as the decay percentage are in values of percentage (0-100%). The slow-down window is in units of analog-to-digital converter counts and drive time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x96	CRC	ETX

Response Packet

STX	Address	Error	Drive Frequency *(2 bytes)*	Low Rate Duty Cycle

Medium Rate Duty Cycle	High Rate Duty Cycle	Decay Percentage

Slow-Down Window *(2 bytes)*	Drive Time-Out *(2 bytes)*	CRC	ETX

Set Zoom Configuration — Sets the zoom configuration. Drive frequency is in Hertz. Low, medium, and high rate duty cycles as well as the decay percentage are in values of percentage (0-100%). The slow-down window is in units of analog-to-digital converter counts and drive time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x97	Drive Frequency *(2 bytes)*	Low Rate Duty Cycle

Medium Rate Duty Cycle	High Rate Duty Cycle	Decay Percentage

Slow-Down Window *(2 bytes)*	Drive Time-Out *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Get Focus Configuration — Returns the focus configuration. Drive frequency is in Hertz. Low, medium, and high rate duty cycles as well as the decay percentage are in values of percentage (0-100%). The slow-down window is in units of analog-to-digital converter counts and drive time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x98	CRC	ETX

Response Packet

STX	Address	Error	Drive Frequency *(2 bytes)*	Low Rate Duty Cycle

Medium Rate Duty Cycle	High Rate Duty Cycle	Decay Percentage

Slow-Down Window *(2 bytes)*	Drive Time-Out *(2 bytes)*	CRC	ETX

Set Focus Configuration — Sets the focus configuration. Drive frequency is in Hertz. Low, medium, and high rate duty cycles as well as the decay percentage are in values of percentage (0-100%). The slow-down window is in units of analog-to-digital converter counts and drive time-out is in units of 1/100th of a second.

Command Packet

STX	Address	0x99	Drive Frequency *(2 bytes)*	Low Rate Duty Cycle

Medium Rate Duty Cycle	High Rate Duty Cycle	Decay Percentage

Slow-Down Window *(2 bytes)*	Drive Time-Out *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Calibration Time-Out Parameters

When the Model 20 is calibrating the pan/tilt, timers are used to discontinue motion of the motors. This protects the hardware of the Model 20 if a physical problem exists. The recalibration time-out value is user-specified so that completion of each step of the recalibration can be performed regardless of the resolution of the motor or the extent of travel. This eliminates false detection of a hardware error by the firmware.

Get Recalibration Time-Out — Returns the recalibration time-out value in units of 1/100th of a second.

Command Packet

STX	Address	0x9A	CRC	ETX

Response Packet

STX	Address	Error	Recalibration Time-Out *(2 bytes)*	CRC	ETX

Set Recalibration Time-Out — Sets the recalibration time-out value in units of 1/100th of a second.

Command Packet

STX	Address	0x9B	Recalibration Time-Out *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Section 7 - Calibration Commands

The Model 20 firmware provides two commands for calibration and one command to return the step positions of the reference switches.

The two commands for calibration include a “recalibrate” command and a “verify position” command. The “recalibrate” command saves the step positions of the reference switch points. The “verify position” command sends either the azimuth and elevation axis (or both) to their center reference switch points and then returns both to their previous positions. Both commands use timers that are updated after every step of recalibration and discontinue motion of the motors after expiration. This keeps the Model 20 from continuously driving the motors if there is a physical problem with the unit.

For reference in this section, direction “A” is counter-clockwise for the base and front-edge down for the head of the Model 20. Direction “B” is clockwise for the base and front-edge up for the head.

Note: The following two commands, “recalibrate” and “verify center”, return response packets only after their respective operations are complete.

Recalibrate — Moves azimuth and elevation through all the reference switches and records these positions. These positions are used for constant monitoring and correction of the azimuth and elevation axis. When the recalibration is complete, the Model 20 moves both axis to position zero (midpoint of the center reference switch). If the no switch or the incorrect switch is found, the error bytes in the response packets return a non-zero value.

Command Packet

STX	Address	0x3C	CRC	ETX

Response Packet

STX	Address	Error	Azimuth Error *(2 bytes)*	Elevation Error *(2 bytes)*	CRC	ETX

Azimuth and Elevation Errors return one of the following values:

0x0000	no error
0x0101	did not find the center reference
0x020x	error in the center reference switch
0x0301	did not find extent switch A
0x0401	did not find extent switch B

Verify Position — Moves either azimuth, elevation, or both to their respective center reference switch points and then returns both axis to their previous positions. If no switches are found before the reset timer expires, the error bytes in the response packet returns a non-zero value. This command is used for quick recalibration of the Model 20. The **Mode** parameter informs the Model 20 which axis to verify (and is coordinate system dependent).

Mode = 0	no motion
Mode = 1	azimuth
Mode = 2	elevation
Mode = 3	both azimuth and elevation

Command Packet

STX	Address	0x3D	Mode	CRC	ETX

Response Packet

STX	Address	Error	Azimuth Error *(2 bytes)*	Elevation Error *(2 bytes)*	CRC	ETX

Azimuth and Elevation Errors return one of the following values:

0x0000	no error
0x0101	did not find the center reference

Get Reference Switch Positions — Returns the step positions of the reference switches. Positions for azimuth and elevation references are returned in this order: extent switch “A”, center reference switch “A” side - moving in direction “B”, center reference switch “B” side - moving in direction “A”, and extent switch “B” (see the introductory paragraph of this section for a description of “A” and “B”. The references returned are relative to the coordinate system in use. The number of bytes for each reference is dependent upon the command set used.

Command Packet

STX	Address	0x83	CRC	ETX

Response Packet (Short Command Set)

STX	Address	Error	Azimuth Extent A *(2 bytes)*	Elevation Extent A *(2 bytes)*
Azimuth Reference A *(2 bytes)*			Elevation Reference A *(2 bytes)*	
Azimuth Reference B *(2 bytes)*			Elevation Reference B *(2 bytes)*	
Azimuth Extent B *(2 bytes)*		Elevation Extent B *(2 bytes)*	CRC	ETX

Response Packet (Long Command Set)

STX	Address	Error	Azimuth Extent A *(4 bytes)*	Elevation Extent A *(4 bytes)*
Azimuth Reference A *(4 bytes)*			Elevation Reference A *(4 bytes)*	
Azimuth Reference B *(4 bytes)*			Elevation Reference B *(4 bytes)*	
Azimuth Extent B *(4 bytes)*		Elevation Extent B *(4 bytes)*	CRC	ETX

Section 8 - Stop Commands

The Model 20 has four commands that discontinue motion for azimuth and elevation as well as zoom and focus.

Stop Azimuth Motion — Stops the motion of the azimuth axis (which is dependent on the coordinate system). If required, the azimuth axis will decelerate (in a s-curve motion) to its stopping position.

Command Packet

STX	Address	0x16	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Stop Elevation Motion — Stops the motion of the elevation axis (which is dependent on the coordinate system). If required, the elevation axis will decelerate (in a s-curve motion) to its stopping position.

Command Packet

STX	Address	0x17	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Stop Lens Motion — Stops the motion of zoom and focus.

Command Packet

STX	Address	0x1B	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Stop All Motion — Stops all motion of azimuth, elevation, zoom and focus. If required, the azimuth and elevation axis will decelerate (in a s-curve motion) to its stopping position.

Command Packet

STX	Address	0x14	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Section 9 - Movement Commands

The Model 20 includes two commands for controlling direction and speed of the azimuth, elevation, zoom and focus and also four commands for the positioning of azimuth, elevation, zoom and focus. All positioning commands move the azimuth and elevation in a manner, which each axis will arrive at the specified position at nearly the same time. The number of bytes used in command packets requiring an azimuth and elevation position will differ between the “short” and “long” command sets.

Move Azimuth and Elevation — Moves azimuth and elevation based on the direction and step rate. Direction is specified as follows:

bit 0	Elevation direction:	0-negative, 1-positive
bit 1	Elevation motion:	0-stop, 1-move
bit 2	Azimuth direction	0-negative, 1-positive
bit 3	azimuth motion:	0-stop, 1-move
bits 4-7	reserved	

The step rate is specified in steps per second.

Command Packet

STX	Address	0x18	Direction	Azimuth Rate *(2 bytes)*

Elevation Rate *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Move Zoom and Focus — Moves zoom and focus components of a lens in the specified direction at the specified rate. Direction and rate of each component are specified as one byte in the format shown below. For zoom, a value of zero for bit 4 represents zoom out while a value of one represents zoom in. For focus, a value of zero for bit 4 represents focus towards a near object while a value of one represents focus towards a far object.

Bit 0	rate specified as a nibble
Bit 1	0 - no movement,
Bit 2	1 - slow, 2 - medium
Bit 3	3 - fast
Bit 4	0 - negative, 1 - positive
bit 5-7	reserved

Command Packet

STX	Address	0x47	Zoom	Focus	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Go to Azimuth and Elevation Position — Moves azimuth and elevation to the specified position at the fastest rate configured.

Command Packet (Short Command Set)

STX	Address	0x19	Azimuth Position *(2 bytes)*	Elevation Position *(2 bytes)*

CRC	ETX

Command Packet (Long Command Set)

STX	Address	0x19	Azimuth Position *(4 bytes)*	Elevation Position *(4 bytes)*

CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Go to Azimuth and Elevation Position at the Specified Rate — Moves azimuth and elevation to the specified position at the specified rate.

Command Packet (Short Command Set)

STX	Address	0x1A	Azimuth Position *(2 bytes)*	Elevation Position *(2 bytes)*

Azimuth Rate *(2 bytes)*	Elevation Rate *(2 bytes)*	CRC	ETX

Command Packet (Long Command Set)

STX	Address	0x1A	Azimuth Position *(4 bytes)*	Elevation Position *(4 bytes)*

Azimuth Rate *(2 bytes)*	Elevation Rate *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Go to Azimuth, Elevation, Zoom, and Focus Position — Moves azimuth, elevation, zoom and focus to the specified position at the fastest rate possible.

Command Packet (Short Command Set)

STX	Address	0x15	Azimuth Position *(2 bytes)*	Elevation Position *(2 bytes)*

Zoom *(2 bytes)*	Focus *(2 bytes)*	CRC	ETX

Command Packet (Long Command Set)

STX	Address	0x15	Azimuth Position *(4 bytes)*	Elevation Position *(4 bytes)*

Zoom *(2 bytes)*	Focus *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Go to Zoom and Focus Position — Moves zoom and focus to the specified position at the fastest rate.

Command Packet

STX	Address	0x46	Zoom Position *(2 bytes)*	Focus Position *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Section 10 - Preset Commands

The Model 20 implements commands that allow the storing and recalling of a position (azimuth, elevation, zoom, and focus) through the use of presets. Presets are destinations that are used frequently. Storing of these presets on the Model 20 provides for quick recall.

A preset can be stored at the current position of the Model 20 or by specifying the position in a command packet. Two commands are available for these operations. Two more commands instruct the Model 20 to recall a preset and move to that location. The user may also upload or download a block of ten presets for saving to and restoring from the controller.

Set Preset at Current Position — Assigns the current azimuth, elevation, zoom and focus values to the specified preset.

Command Packet

STX	Address	0x1F	Preset	CRC	ETX

Response Packet

STX	Address	Error	Status	CRC	ETX

Status returns as one of the following:

Status = 0	command executed
Status = 1	invalid preset specified

Set Preset at Specified Position — Assigns the specified azimuth, elevation, zoom and focus values to the specified preset.

Command Packet (Short Command Set)

STX	Address	0x20	Preset	Azimuth Position *(2 bytes)*	Elevation Position *(2 bytes)*

Zoom Position *(2 bytes)*	Focus Position *(2 bytes)*	CRC	ETX

Command Packet (Long Command Set)

STX	Address	0x20	Preset	Azimuth Position *(4 bytes)*	Elevation Position *(4 bytes)*

Zoom Position *(2 bytes)*	Focus Position *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	Status	CRC	ETX

Status returns as one of the following:

Status = 0	command executed
Status = 1	invalid preset specified

Get Position Stored at Preset — Returns the azimuth, elevation, zoom and focus values assigned to the specified preset.

Command Packet

STX	Address	0x24	Preset	CRC	ETX

Response Packet (Short Command Set)

STX	Address	Error	Status	Preset	Azimuth Position *(2 bytes)*

Elevation Position *(2 bytes)*	Zoom Position *(2 bytes)*	Focus Position *(2 bytes)*	CRC	ETX

Response Packet (Long Command Set)

STX	Address	Error	Status	Preset	Azimuth Position *(4 bytes)*

Elevation Position *(4 bytes)*	Zoom Position *(2 bytes)*	Focus Position *(2 bytes)*	CRC	ETX

Status returns as one of the following:

Status = 0	command executed
Status = 1	invalid preset specified

Get the Number of Presets Available — Returns one byte whose value contains the number of presets available for use.

Command Packet

STX	Address	0x25	CRC	ETX

Response Packet (Short Command Set)

STX	Address	Error	Presets Available	CRC	ETX

Move to the Position Stored in Preset — Moves the azimuth, elevation, zoom and focus to the position stored in the specified preset.

Command Packet

STX	Address	0x1E	Preset	CRC	ETX

Response Packet

STX	Address	Error	Status	CRC	ETX

Status returns as one of the following:

Status = 0	command executed
Status = 1	invalid preset specified

Move to the Position Stored in Preset at the Specified Rate — Moves the azimuth, elevation, zoom and focus to the position stored in the specified preset. Azimuth and elevation move at the rates in the command packet. Zoom and focus move at the fastest rate.

Command Packet

STX	Address	0x23	Preset	Azimuth Rate *(2 bytes)*

Elevation Rate *(2 bytes)*	CRC	ETX

Response Packet

STX	Address	Error	Status	CRC	ETX

Status returns as one of the following:

Status = 0	command executed
Status = 1	invalid preset specified

Upload Block of Presets — Uploads the azimuth, elevation, zoom and focus assigned to a block of ten presets. Each preset is arranged in the following manner depending upon the command set in use:

Preset Position Information (Short Command Set)

Azimuth *(2 bytes)*	Elevation *(2 bytes)*	Zoom *(2 bytes)*	Focus *(2 bytes)*

Preset Position Information (Long Command Set)

Azimuth *(4 bytes)*	Elevation *(4 bytes)*	Zoom *(2 bytes)*	Focus *(2 bytes)*

The preset specified corresponds to a block of ten presets. The block, which the preset resides, is the block returned. For example, if the preset specified is a number between 0 and 9, then presets 0 through 9 are returned. If the preset specified is a number between 30 and 39, then presets 30 through 39 are returned.

Command Packet

STX	Address	0x21	Preset	CRC	ETX

Response Packet

STX	Address	Error	Status	Preset	n^{th} Preset	$(n+1)^{th}$ Preset	...

$(n+8)^{th}$ Preset	$(n+9)^{th}$ Preset	CRC	ETX

Status returns as one of the following:

Status = 0	command executed
Status = 1	invalid preset specified

Download Block of Presets — Downloads the azimuth, elevation, zoom and focus and assigns them to a block of ten presets. Each preset is arranged in the following manner depending upon the command set in use:

Preset Position Information (Short Command Set)

Azimuth *(2 bytes)*	Elevation *(2 bytes)*	Zoom *(2 bytes)*	Focus *(2 bytes)*

Preset Position Information (Long Command Set)

Azimuth *(4 bytes)*	Elevation *(4 bytes)*	Zoom *(2 bytes)*	Focus *(2 bytes)*

The preset specified corresponds to a block of ten presets. The block, which the preset resides, is the block assigned. For example, if the preset specified is a number between 0 and 9, then presets 0 through 9 are assigned. If preset specified is a number between 30 and 39, then presets 30 through 39 are assigned.

Command Packet

STX	Address	0x22	Preset	n^{th} Preset	$(n+1)^{th}$ Preset	...

$(n+8)^{th}$ Preset	$(n+9)^{th}$ Preset	CRC	ETX

Response Packet

STX	Address	Error	Status	CRC	ETX

Status returns as one of the following:

Status = 0	command executed
Status = 1	invalid preset specified

Section 11 - Movement Information Commands

The Model 20 provides movement information commands, which return the operating states of azimuth, elevation, zoom and focus. For azimuth and elevation, the user can determine the motion, direction, acceleration, position, and step rate. For zoom and focus, the user can determine motion, direction, and position.

Return Azimuth and Elevation Status Flags — Returns the current state of motion of azimuth and elevation.

Command Packet

STX	Address	0x42	CRC	ETX

Response Packet

STX	Address	Error	Azimuth Status	Elevation Status	CRC	ETX

Azimuth and Elevation Status is returned as indicated below:

bit 0	motion	1 - moving, 0 - stopped
bit 1	direction	1 - positive, 0 - negative
bit 2-4	*internal use*	
bit 5	low power mode	1 - low power, 0 - normal operation
bit 6	*internal use*	
bit 7	axis error	1 - axis error, 0 - normal operation

Low power mode or an axis error inhibits that axis from moving. Low power mode is used to conserve power the Model 20 and must be exited before any movement command is executed (see section 12). An axis error is a condition where the previous “recalibrate” command could not be successfully completed due to a physical problem with the Model 20. The axis will begin working only after the problem is corrected and a “recalibrate” command is successfully completed (see section 7).

Return the Current Azimuth and Elevation Position — Returns the current azimuth and elevation position. This command can be used while either axis is in motion.

Command Packet

STX	Address	0x41	CRC	ETX

Response Packet (Short Command Set)

STX	Address	Error	Azimuth Position *(2 bytes)*

Elevation Position *(2 bytes)*	CRC	ETX

Response Packet (Long Command Set)

STX	Address	Error	Azimuth Position *(4 bytes)*

Elevation Position *(4 bytes)*	CRC	ETX

Return the Current Azimuth and Elevation Steps Rates — Returns the current azimuth and elevation step rates. The command may be used while either axis is in motion. The step rates are in units of steps per second.

Command Packet

STX	Address	0x51	CRC	ETX

Response Packet

STX	Address	Error	Azimuth Rate *(2 bytes)*	Elevation Rate *(2 bytes)*	CRC	ETX

Return the Current Azimuth and Elevation Acceleration State — Returns the current azimuth and elevation acceleration state. The command may be used while either axis is in motion.

Command Packet

STX	Address	0x52	CRC	ETX

Response Packet

STX	Address	Error	Azimuth Acceleration State	Elevation Acceleration State

CRC	ETX

The acceleration state is returned as one of the values below:

Acceleration State = 0	no motion
Acceleration State = 1	acceleration
Acceleration State = 2	constant rate
Acceleration State = 3	deceleration

Return Zoom and Focus Status Flags — Returns the current state of motion for zoom and focus.

Command Packet

STX	Address	0x50	CRC	ETX

Response Packet

STX	Address	Error	Zoom Status	Focus Status	CRC	ETX

Zoom and Focus Status is returned as indicated below:

bit 0	motion	1 - moving, 0 - stopped
bit 1	direction	1 - positive, 0 - negative
bit 2-7	*internal use*	

Return the Current Zoom and Focus Position — Returns the current zoom and focus position. The command may be used while zoom or focus is in motion.

Command Packet

STX	Address	0x43	CRC	ETX

Response Packet

STX	Address	Error	Zoom Position *(2 bytes)*	Focus Position *(2 bytes)*	CRC	ETX

Section 12 - Low Power Commands

The Model 20 provides two modes of reduced power consumption, which are useful for applications where power conservation is required. These two modes are low power and sleep modes. While in low power mode, power is removed from the motors and no movement commands are acknowledged. Two commands are provided to enter and exit low power mode. In sleep mode, all processor clocks in the Model 20 are stopped and power is removed from the motors. To exit sleep mode, the two pins of J8 on the CPU card of the Model 20 must be shorted together. When this occurs, the Model 20 resumes normal operation.

Enter Low Power Mode — Removes power to the azimuth and elevation motors to conserve power and reduce heat. Any movement commands while in low power mode are acknowledged but no motion takes place.

Command Packet

STX	Address	0xFD	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Exit Low Power Mode — Reapplies power to the azimuth and elevation motors and the Model 20 resumes normal operation.

Command Packet

STX	Address	0xFE	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Enter Sleep Mode — Removes power from the azimuth and elevation motors and forces the processor to enter a low power mode in which all processor clocks stop. No commands are acknowledged or processed while in this mode. Shorting the two pins on J8 causes the Model 20 to resume normal operation. Another method to “wake” the Model 20 is to apply a high to low transition on pin one of J8. Pin one of J8 is pulled high by a 5K-ohm resistor. Pin two of J8 is tied to ground. Any transition on J8 has no effect while the Model 20 is not in sleep mode. **No response packet is returned to the controller for this command.**

Command Packet

STX	Address	0xFF	CRC	ETX

Section 13 - Auxiliary Serial Port Commands

The Model 20 provides two independent serial ports for controlling other devices within the user's application. These commands allow the user to configure the serial port, transmit a string of characters, retrieve the characters in the receive buffer, check the number of characters in the receive buffer, and flush the receive buffer. The size of both the transmit and receive buffers for both ports are fixed at 100 bytes. Transmit, receive and ground for auxiliary port 1 is JP14 on the CPU card. Auxiliary Port is JP13 on the CPU card.

Configure Auxiliary Port 1 — Sets the baud rate, parity, and number of data bits of auxiliary port one. The baud parameter is specified as one of the following values:

baud = 2	1200 baud
baud = 3	2400 baud
baud = 4	4800 baud
baud = 5	9600 baud
baud = 6	19200 baud

The parity parameter is specified as one of the following values:

parity = 0	no parity
parity = 1	even parity
parity = 2	odd parity

The data bits parameter should be specified as either seven or eight.

Command Packet

STX	Address	0x5A	Baud	Parity	Data Bits	CRC	ETX

Response Packet

STX	Address	Error	Status	CRC	ETX

Status returns the following:

status = 0	command executed
status = 1	invalid parameter

Configure Auxiliary Port 2 — Sets the baud rate, parity, and number of data bits of auxiliary port two. See the above command for details.

Command Packet

STX	Address	0x5F	Baud	Parity	Data Bits	CRC	ETX

Response Packet

STX	Address	Error	Status	CRC	ETX

Transmit Characters out Auxiliary Port 1 — Places the transmit string into the auxiliary port 1 transmit buffer. All characters (0-255) are allowed in the transmit string and no character manipulation is performed.

Command Packet (Variable Length)

STX	Address	0x5B	Size	Transmit String *("Size" bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Transmit Characters out Auxiliary Port 2 — Places the transmit string into the auxiliary port 1 transmit buffer. All characters (0-255) are allowed in the transmit string and no character manipulation is performed.

Command Packet (Variable Length)

STX	Address	0x60	Size	Transmit String *("Size" bytes)*	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Receive Characters from Auxiliary Port 1 — Returns the number of characters specified from the auxiliary port 1 receive buffer. If there are fewer characters in the receive buffer than desired, all characters in the receive buffer are returned.

Command Packet

STX	Address	0x5C	Number of Characters	CRC	ETX

Response Packet (Variable Length)

STX	Address	Error	Size	Receive String *("Size" bytes)*	CRC	ETX

Receive Characters from Auxiliary Port 2 — Returns the number of characters specified from the auxiliary port 2 receive buffer. If there are fewer characters in the receive buffer than desired, all characters in the receive buffer are returned.

Command Packet

STX	Address	0x61	Number of Characters	CRC	ETX

Response Packet (Variable Length)

STX	Address	Error	Size	Receive String *("Size" bytes)*	CRC	ETX

Get Auxiliary Port 1 Receive Buffer Size — Returns the number of characters in auxiliary port 1 receive buffer.

Command Packet

STX	Address	0x5D	CRC	ETX

Response Packet

STX	Address	Error	Number of Characters	CRC	ETX

Get Auxiliary Port 2 Receive Buffer Size — Returns the number of characters in auxiliary port 2 receive buffer.

Command Packet

STX	Address	0x62	CRC	ETX

Response Packet

STX	Address	Error	Number of Characters	CRC	ETX

Flush Auxiliary Port 1 Receive Buffer — Flushes the auxiliary port 1 receive buffer.

Command Packet

STX	Address	0x5E	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX

Flush Auxiliary Port 2 Receive Buffer — Flushes the auxiliary port 2 receive buffer.

Command Packet

STX	Address	0x63	CRC	ETX

Response Packet

STX	Address	Error	CRC	ETX