VeriColor™

Identification System

Hub Command Users Manual for use with VeriColor Software 2.0

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X-Rite®

Table of Contents

Getting Started

If this is the first time you are communicating directly to the VeriColor Hub, please read this section carefully. The following tips will save you lots of time and grief…

Notes and Tips

- Although the VeriColor Hub contains two serial ports (RS-232 and RS-485) and an Ethernet Port, the commands specified in this manual all apply. The only difference when using Serial Port vs. Ethernet are the termination characters (specified in more detail later in this section)

- (This is no longer an issue with VeriColor Software versions 1.1 and above) VeriColor 1.0 Software communicates to the hub in a proprietary protocol. Once the hub communicates to 1.0 Software, *it will not respond to regular commands sent through the same serial port until the hub is reset.* When in doubt, reset the Hub by using the "Reset" button located on the upper right hand corner button of the membrane switch. This reset merely toggles power off/on so no settings stored in the Hub are lost.

- Default Communication settings for the RS-232 port are 19200 BAUD, 8N1. Baud rate for the RS-232 is fixed and cannot be altered.

- When communicating over the serial port (RS-232 or RS-485), each command sent to the Hub requires a "Carriage Return" terminating character (ASCII value of 13 decimal or 0D in hex). The terminating character notifies that the command has completed and will respond back.

    - If using a PLC to input Serial Commands, the terminating character is usually entered as **\0D** instead of **0D**. **0D** by itself without the backslash will send two characters instead of the single ASCII value used for Carriage Return, and thus will not work. If \OD doesn't work, also try **$13** (on some PLC's).

- All commands finish their response with a "**<##>**" packet. Some commands respond with a different number of packets, so keep receiving packets until the status <##> one is received. This manual documents the format of each command.

- All VeriColor Hubs default to Ethernet being switched off. To use Ethernet, you will have to first send configuration commands (See **eg** and **es** commands) or use VeriColor Software in the Setup/Diagnostics Menu.
    - The proper settings for the Ethernet are highly dependant on your local network. Consult your local IT professional for setup assistance.
    - If you want to connect directly from a PC to a Hub via Ethernet, you will have to use a *Crossover Ethernet cable*. Also the IP address of the hub has to be compatible with the setting of your Computer.

Useful Commands

This area will list some common situations and briefly describe which commands to use. In each case below, these functions can all be done using the included VeriColor software or via digital I/O provided.

- Trigger a Measurement (or detecting when one has taken place)

- o   Measure (**ma**) – Triggers a measurement immediately
- o   Poll Hub (**ph**) – Used to detect new measurements

- Selecting a new Standard or knowing the current one
  - o   Standard Active (**sa**) – This command can be used to set or get the current Standard
  - o   Standard Get (**sg**) – This command can be used to get more specific information about the current standard than an index # (1-50)

- Retrieving Data from the last measurement
  - o   Get Reading (**gr**) – This command has many forms that can return all aspects from the last measurement's reflectances, color difference values, and Pass/Fail

- Configuration Settings
  - o   Configure (**cf**) – This command has many settings that can control Auto Standard Select, Pass/Fail On/Off, etc.

Examples of using Commands

- Example of a Serial RS-232 command for triggering a Measurement

  (ASCII string sent to the Hub)
  ma[CR]

  (ASCII String response from the hub after a successful measurement is complete)
  <00>[CR][LF]

  [CR] = represents a single ASCII value of 13 or 0D (hex) Carriage Return
  [LF]   = represents a single ASCII value of 10 or 0A (hex) Line Feed

  <00> = represents four actual ASCII characters received. The two numbers inside of the < and > symbols represent an Error Status to the command requested. In most cases <00> means the command was successful, if not it is explained in the specific command.

- Example of a Serial RS-232 command for getting measurement Results

  (ASCII string sent to the Hub, results for Head #1)
  101gr[CR]

  (ASCII String response from the hub including measurement data from Head #1)
  200,1500,2000,2500,5500,5000,3500,2000,1500[CR][LF]
  <00>[CR][LF]

Conventions

Numbers ending with the letter 'h' are hexadecimal. All others are decimal.

All commands minimally respond with a status packet. A status packet has the format: <ss> where **ss** is a code indicating any error that might have occurred while processing the command. <00> indicates there was no problem processing the command.

Note: please check the X-Rite website (www.xrite.com) for the latest version of this file.

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COMMAND DESCRIPTIONS

Baud Rate (br)

SYNTAX: ######**#br**

      Where: ###### is a baud Rate

DESCRIPTION:This setting only affects the RS-485 serial port. Currently there are only two settings, **19200** and **115200** where **19200** is the default. The baud rate change is effective immediately after the final response is sent. More settings may be added in the future.

NOTE: **This setting only affects the baud rate to the RS-485 Serial port B. Serial port A (RS-232) remains fixed at 19200.**

RESPONSE: <00> if no errors occurred

CLEAR ERRORS (ce)

SYNTAX: **ce**

DESCRIPTION:Clears all errors in the error log. If the hub is in Error Mode, it will be reset back to Normal Mode (Sample).

RESPONSE: <00>

CONFIGURE (cf)

SYNTAX: ****##cf**

      Where: ** is the option selection.
             ## is the index to the item to be configured.

DESCRIPTION:This command is used to configure various options in the hub.

RESPONSE: If an index (##) is provided, but no option selection (**), the response will be the present setting of the item selected. If (##) isn't provided either, the list of available settings will be sent. Command always finishes with a <ss> status packet.

      ss is one of the following status codes:

           00   no error
           01   parameter out of range or invalid

      The following are a list of the configuration items and their options (Note: An asterisk (*) indicates the default setting):

Number (##)	**Description**	**Options (**)**

00	Outputs this list of available settings	
01	Enable/Disable Button Lockout on hub. (except reset & measure buttons)	00 = disabled* 01 = enabled
02	Auto Standard Search Mode	00 = disabled 01 = dLED Search* 02 = dIntensity Search 03 = dColor Search
03	Enable/Disable Pass/Fail Mode	00 = disabled 01 = enabled*
04	Set/Get PLC Output Timeout A setting of 0 disables the timeout so outputs stay high indefinitely.	00-99 seconds timeout 15 Seconds is default
05	Set/Get PLC Output Mode This setting refers directly to the PLC outputs labeled "1/A to 32/F"	00 = Binary Standard Mode* 01 = Head Active Pass 02 = Head Active Fail
06	Measure Mode	00 = Sequential* 01 = Simultaneous
07	Sample Averaging	01-99 Measurements 1 is default which means averaging is off
08	Auto Averaging Time Pause	01 - 99 Time in .1 second increments, so range is .1 to 9.9 seconds if set to 00 then Auto Averaging is off (Default 00)
09	Digital Filtering	00 - 99 Filter Factor To enable digital filtering, this setting must be set to 2 or higher. Setting it to 0 or 1 turns it off. Digital filtering overrides any sample averaging settings from above.
10	Measure Trigger Delay	01 - 99 Time in .1 second increments, so range is .1 to 9.9 seconds if set to 00 then Measure Trigger Delay is off (Default 00)

CHECK LOCKOUT (cl)

SYNTAX: **cl**

DESCRIPTION: Returns the status of the PLC Lockout Input. This command is only useful on B type hubs.

RESPONSE: #
             <00>

             Note: Response of 0 means its not active, or
                     response of 1 means the PLC Lockout input is active

ETHERNET GET (eg)

SYNTAX: ##**eg**

             Where: ## is the Ethernet Setting requested, see table below

DESCRIPTION: This command is used to view various Ethernet settings in the hub.

RESPONSE: Responds with the present setting of the selected configuration option. The
             response varies depending on the option selected. If invalid parameters are sent,
             then the response will be 0's followed by the <00>.

Number (##)	Description
00	Returns Ethernet Get Help List
01	Returns the stored hub IP address in the format: xxx.xxx.xxx.xxx If DHCP is enabled this address may differ from the IP actually being used.
02	Returns the present hub name. This name may be used in place of the IP address to communicate to the hub. The maximum name length is limited to forty characters.
03	Returns the present name server IP address in the format: xxx.xxx.xxx.xxx
04	Returns the present gateway IP address in the format: xxx.xxx.xxx.xxx
05	Get the MAC Address. Returns the present MAC address in the format: xx:xx:xx:xx:xx:xx
06	Get Enable DHCP Flag. 0 = disabled, 1 = enabled
07	Get Ethernet Enabled Flag. 0 = Disabled, 1 = enabled
08	Returns the present network address mask in the format: xxx.xxx.xxx.xxx

ENABLE HEADS (en)

SYNTAX: (##)**en**

             Where: ## is a bit pattern indicating which heads are enabled or disabled. If ##
                    is not provided, this command returns the present configuration.

DESCRIPTION: This command is used to enable or disabled up to six sensor heads in the
             system. For each head if the corresponding bit is high (1) the head is enabled. If
             the bit is low (0) the head is disabled. Bit 0 corresponds to head number 1 and
             bit 4 corresponds to head 5. The other bits correspond to each of the remaining
             heads respectively.

Example: If heads 1, 3, and 5 are to be enabled and 2 and 4 disabled the following command would be sent to the hub: **15en** (Hex number). All Heads are enabled as default (**3fen)**.

RESPONSE: **aa**
<00>

Where: **aa** is the bit pattern of the heads that are enabled/disabled in Hex number form.

ETHERNET SET (es)

SYNTAX: **##es**

Where: ## is the Ethernet Setting to set, see table below

DESCRIPTION: This command is used to set various Ethernet settings in the hub.

RESPONSE: Depending on the ## passed in, the hub will expect the specified data to be sent. If a bad parameter is sent or the data was in a different format than expected a Bad Command response will return <01>. Otherwise, if the new setting is accepted it will return <00>

NOTE: **When changing Ethernet settings, it should be disabled using the 07en command first. Once all Ethernet settings are complete should it be enabled again 07en.**

Number (##)	Description
00	Returns Ethernet Set Help List
01	Set the hub IP address. The expected format is: xxx.xxx.xxx.xxx
02	Set the present hub name. This name may be used in place of the IP address to communicate to the hub. The maximum name length is limited to forty characters.
03	Set the name server IP address in the format: xxx.xxx.xxx.xxx
04	Set the gateway IP address in the format: xxx.xxx.xxx.xxx
05	The MAC Address is not changeable.
06	Set the Enable DHCP Flag. 0 = disabled, 1 = enabled
07	Set the Ethernet Enabled Flag. 0 = Disabled, 1 = Enabled. When this setting is zero, the Ethernet on the hub is not active or even connect on powerup. When the setting is enabled, there will be a slight pause after the response is returned while the hub initializes its Ethernet connection. It is important to have the correct settings above in place before the it is made active. To re-intialize the Ethernet connection, send this command to enable the Ethernet again.
08	Set the network address mask in the format: xxx.xxx.xxx.xxx

FIXTURE GET (fg)

SYNTAX: **fg**

DESCRIPTION: Returns the Fixture name stored in the Hub. The fixture name can be up to 40 characters in length.

RESPONSE: Assembly line 11234412-41
<00>

Note: Fixture name defaults to "<NONE>".

FIXTURE SET (fs)

SYNTAX: **fs**

DESCRIPTION: The hub will expect a Fixture name to be input. The name can be up to 40 characters maximum.

RESPONSE: <00>

Note: Will return a <01> if the name string is NULL. Strings longer than 40 characters will be truncated.

GET ERRORS (ge)

SYNTAX: **ge**

DESCRIPTION: Returns a string of error codes. Getting this error list does not clear it out until the "ce" command is sent.

RESPONSE: **xxx,xxx,xxx,xxx,...xxx**
<00>

Where: **xxx** - individual error code, see Appendix A for a detailed listing of error codes and their meaning.

GET READING (gr)

SYNTAX: ***##gr**

Where: * is the Head # (1-6) (not required for all types of information)
is the type of information requested, listed below

00 = Returns list of parameters
01 = Get current dLED and sample reflectances per head
02 = Get Pass/Fail Statuses
03 = Get Sample Averaging Status
04 = Get dIntensity and dColor sample Values
97 = Get Compare Mode Data Packet per head
98 = Get Software Learn Data Packet per head
99 = Get Target Data Packet

DESCRIPTION: This command is used to gather Sample data from each head representing the last measurement it took.

RESPONSE: Responds with the present setting of the selected configuration option. The response varies depending on the option selected. Invalid parameters will return 0's followed by the <00> status.

0000gr – Help List. Returns a help list of parameters.

#01gr – Get Head dlED and Reflectances. The hub returns a string of reflectances for the requested head (# parameter) "yyyyy,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx" where xxxxx is an ASCII word where 10,000 = 100.00% reflectance. yyyyy represents the dLED number between the current standard and current sample; a value of 100 = 1.00 dLED.

02gr – Get Pass/Fail Statuses. Returns a string of pass/fail flags in the format "z,z,z,z,z,z,z". z is either a 0 for a Fail, 1 for a pass, or 2 for N/A. The first number in the response represents the overall Pass/Fail status for the last reading. This command is not head Specific so the head # is ignored. Heads that aren't enabled/used will default their status to N/A but it won't be used to determine the overall Pass/Fail. Values will be N/A also for a standard that has zero for Tolerance or if Pass/Fail in configuration is off.

03gr – Get Sample Averaging Status. Returns a string of a couple numbers in the format "y,z" 'y' is how many measurements have been taken towards the running average and z is how many measurements are needed to be made before a sample is complete. So "2,5" means the last measurement was 2 out of 5.

#04gr – Get dIntensity and dColor Values. Returns an ASCII string of a couple numbers in the format "aaaaa,bbbbb". aaaaa represents the dIntensity number and bbbbb the dColor value for the requested head (# parameter). This command reports the differences between the sample and the current standard.

#97gr – Get Compare Mode Packet. This command returns the following response if the hub is indeed in the proper operating mode. Head # is required.

        xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx
        <00>

        xxxxx – Set of Eight reflectances representing the latest measurement.

#98gr – Get Head Software Learn Mode Packet. This command returns the following response if the hub is indeed in the proper operating mode. Head # is required.

        xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx
        <00>

        xxxxx – Set of Eight reflectances representing the latest measurement.

99gr – Software Target Get Data Packet. This command returns the current Targeting Head's data, so no Head # is required for this command.

      Software or Manual Targeting Mode
        a,bbbbb,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx
        <00>

        a – Current Head # being targeted (1-6)

bbbbb – dLED value between the last measurement and the head's associated Tolerance Standard
xxxxx – Set of Eight reflectances representing the latest measurement

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HEAD LIST (hl)

SYNTAX: ****##hl**

    Where: ** is used as a Set Flag
        ## is the type of information requested, listed below

            00 = Current Head List
            01 = Master Head List

DESCRIPTION: This command can be used to view both the Current and Master Head Lists. The Master Head List can be set using the command as well.

RESPONSE: Responds with the present setting of the selected configuration option. The response varies depending on the option selected.

0000hl – Get Current Head List. Returns the current state of the hub. This list is generated internally each power-up and cannot be modified. The string that returns will be in the following format "xxxxx,xxxxx,xxxxxx,xxxxx,xxxxx,xxxxx" Each number is a ULONG ASCII serial number of each head. Order is important, so the first number is always from the 1st head and the last is the 6th head. If a serial number is zero it means that head doesn't exist. There will never be gaps in a head list.

0001hl – Get Master Head List.   The Master Head List is returned in the same format as the Current Head List above. Each time the hub powers-up, it will generate the Current List and check it against the Master List. If doesn't match exactly, the hub will enter an error state. If the Master Head List hasn't been set, then no check will be performed and the hub will accept any current head list.

0101hl – Set Master Head List. With this set of parameters, the hub will be expecting a string with the same format as the above lists. Each time a Project gets downloaded, it should include this setting. If a particular project does not use one of the current Heads, it should not be set to zero, instead disable it with the Head Enable command. Head Serial Numbers set to "00001" are reserved as Virtual Heads in emergency situations.

HUB MODE (hm)

SYNTAX: **##hm**

    Where: ## is used to Set the current Hub Mode. Not sending parameters will return the current hub mode number based on the following table.

            00 – SAMPLE MODE
            01 – MANUAL LEARN MODE
            02 – SOFTWARE LEARN MODE
            03 – MANUAL TARGET MODE
            04 – SOFTWARE TARGET MODE
            05 – SYSTEM STARTUP MODE
            06 – COMPARE MODE

DESCRIPTION: This command is used by software to get/set the current Operating mode of the Hub.

RESPONSE: If no parameters are sent with the command, the response is the current Hub Mode ## and a <00>. If a parameter is sent, the Hub will attempt to change to the new operating mode. Not all modes are accessible by software, if the new mode is not accepted the command will return a <01> response. One example is once the Hub enters Error mode, it will not accept operating mode changes. The best way to return to Sample mode is with the (**ce**) clear error command or (**re**) reset the hub.

LEARN AVERAGE MASK (la)

SYNTAX: **##la**

Where: ## is used as a Set Flag

DESCRIPTION: This command should only be used in conjunction with Manual Learn Mode (see **hm** command) and should be sent before any learn measurements are taken. The running average number must be zero for this setting to be accepted. An Averaging mask is a BYTE where each bit represents a head. Each mask number tells the hub which heads should have their measurements averaged together and copied back over the measured data. This simulates having a larger spot size. With six possible heads, there can be at the most three combinations of averaging. There are six slots for storage. Heads that don't average with other heads do not need an averaging setting.

RESPONSE: Responds with the present setting of the selected configuration option. The response varies depending on the option selected.

00la – Get Average Masks. Returns the current setting. The format is as follows...
"xx,xx,xx,xx,xx,xx" Each number is a BYTE in **ASCII Hex**. If all numbers are zero, then the hub will not average any heads together. Order is not important except that all real settings will show up first in the list before ones that are zero.

01la – Set Average Masks. Once these parameters are used, the hub will await a string with the same format as above. This command will return an error code if learn measurements have already been taken.

LEARN BACK (lb)

SYNTAX: **lb**

DESCRIPTION: When in Manual Learn Mode, this command can be sent the previous measurement taken. Manual Learn mode allows up to 10 measurements to be made towards a standard, and each measurement can be removed one at a time with this command until no measurements are left.

RESPONSE: Responds with a <00> if it was successful in removing the last measurement from the Learn average. It will return a bad command if the Hub is not in Manual Learn Mode or there haven't been any measurements averaged together yet.

LEARN CLEAR (lc)

SYNTAX: **lc**

DESCRIPTION: When in Manual Learn Mode, this command resets the running average number to zero. This allows the user to start measuring their Standard all over again. This command should be sent whenever a user starts to edit a new Standard in software.

RESPONSE: Responds with a <00> if it was successful. It will return a bad command if the Hub is not in Manual Learn Mode.

LOAD DEFAULTS (ld)

SYNTAX: **ld**

DESCRIPTION: This command performs "Factory Presets". <u>Everything is cleared out</u> except for Model Type, and Hub Serial Number. Remember to follow up this command with a (**mp**) Make Permanent command.

RESPONSE: <00>

MEASURE (ma)

SYNTAX: **ma**

DESCRIPTION: Causes the Hub to send the measure command to every enabled head. After all heads have completed measurement the hub retrieves reflectance values and processes them based on its configuration.

RESPONSE: <00> if successful

Where: ss is one of the following status codes:

    00   no error
    01   parameter out of range or invalid
    05   Busy Status – the hub is currently waiting for a Measure Trigger Pause or is in the middle of Auto Averaging
    30   Failed Measurement (see **ge** to see which head(s) failed)

MAKE PERMANENT (mp)

SYNTAX: **mp**

DESCRIPTION: All current settings of the Hub are stored permanently in non-volatile memory. This command should be used after all settings have been completed.

Performing this command after each setting would only cause excess wear/tear on the flash memory over its lifetime.

RESPONSE: Possible Error codes returned. No error, Bad Command, Make Permanent process failed...

MEASURE STATUS (ms)

SYNTAX: **ms**

DESCRIPTION: This command is used to check the current status of the heads. Whenever the hub powers up, it will go into System Startup Mode (see **hm** command) while the heads come up to operating temperature. While warming up, individual head statuses could be gathered from here or simply wait for the Hub Mode (**hm** command) to return to normal.

RESPONSE: **xx,xx,xx,xx,xx,xx**
              <00>

              Where each **xx** represents a single head, head #1 being the first number listed. The following table describes the possible numbers.

                  60 = HEAD READY STATUS
                  61 = NO HEAD STATUS
                  62 = HEAD WARMUP STATUS
                  63 = HEAD BAD HARDWARE STATUS

PROJECT CLEAR (pc)

SYNTAX: **pc**

DESCRIPTION: This command clears out the current Project data. The types of data cleared are the Project Name and the Head Search Weight Factors. All strings are defaulted to "<NONE>" and group #'s all set to 0.

RESPONSE: <00> No reason this should ever fail.

PROJECT GET (pg)

SYNTAX: **##pg**

              Where: ## is used as a Data Type Setting

DESCRIPTION:These commands are used to obtain current project data from the hub.

RESPONSE: Responds with the present setting of the selected configuration option. The response varies depending on the option selected. If parameters are invalid, then data returned will be either <NONE> or 0's followed by the <00> status depending on the Data type requested.

01pg – Get Project Name.   This returns the current Project Name String. Up to 40 characters plus a null terminator.

05pg – Get Head Search Weight Factors. This returns six comma separated values. Each value represents a head's search weight factor. The higher the number, the more influence that head has when searching for the closest standard. Each value can range from 0 to 5, where 0 means the head does not count in searching at all, to 5 which is the highest priority. The default value for each head is 1.

POLL HUB (ph)

SYNTAX: **#ph**

Where: if # is a value greater than 0 sent as a parameter will reset the poll flag. If the parameter is zero or left out, the response will indicate whether a new measurement has been made or not.

DESCRIPTION: This command will be sent often to the hub in order to know when the hub has taken a measurement triggered by any source. Once a measurement is taken, this command will respond with <00> responses until the poll flag is reset with a (1ph). Pollling the hub should be performed from one application at a time, this is important because it is possible to have multiple applications accessing/monitoring the Hub's operation at once. Having more than one application polling the hub could cause confusion.

RESPONSE: <ss>

Where: ss is one of the following status codes:

          00   A new measurement has been made, request for data or the flag has been reset.

          01   No new measurements have been made since the poll flag has been reset

          02   A measurement was made towards a Sample Average in Manual mode. Once the last reading is made towards an average this command will return a <00> response.

          03   A measurement was made towards a Sample Average in Auto Mode. After the series of measurements have completed, this command will respond with a <00> response

          04   The hub is in an error state, and the error must be resolved before further readings can take place

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PROJECT SET (ps)

SYNTAX: **##ps**

Where: ## is used as a Data Type Setting

DESCRIPTION: These commands are used to set the current project data in the hub. Information for each setting is not entered into the command, instead this command is used to specify the type of information being sent to the hub.

RESPONSE: Responds with the present setting of the selected configuration option. The response varies depending on the option selected.

01ps – Set Project Name.   Using this command, the hub will expect a name to follow (41 characters max including null terminator). NULL strings will be rejected with a bad command response.

05ps – Set Head Search Weight Factors. Using this command, the hub will expect a string of 6 ASCII comma separated values. Each value represents a head's search weight factor. The higher the number, the more influence that head has when searching for the closest standard. Each value can range from 0 to 5, where 0 means the head does not count in searching at all, to 5 which is the highest priority. The default value for each head is 1.

RESET (re)

SYNTAX: **#re**

Where: # is as a Reset Head Only flag.

DESCRIPTION: If a 1 is sent as the parameter, only the Heads will be reset. A <00> Packet will return after the process is complete.

If no parameter or a zero is sent, then both the Hub and Heads will be reset together. A <00> response will be sent before the Hub resets. There will be no communications sent from the Hub after a reset.

NOTE: **Any time heads are disconnected or added to a powered hub, they will not communicate or work until the hub is reset (re) or just the heads (1re). It is recommended that the hub be powered down when heads are being added or removed from the system.**

RESPONSE: <00> for success or <01> if a bad parameter is sent

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STANDARD ACTIVE (sa)

SYNTAX: **##sa**

Where: ## is the Standard number (1 to 50 ASCII)

DESCRIPTION: The number specified becomes the current Standard. Only the current standard can have its information accessed. If no parameter is sent, the current standard number is returned before the response.

RESPONSE: <00> if no errors occurred

STANDARD CLEAR (sc)

SYNTAX: ##**sc**
                 Where: ## is the Standard Number 1 - 50

DESCRIPTION: If a correct parameter is sent, only the specified parameter gets cleared. If no
                 parameter is sent then all standards get cleared.

RESPONSE: <00> If the parameter was not 1-50, it will return a bad command status.

STANDARD GET (sg)

SYNTAX: ****#\#sg**

                 Where: ## is used as a Data Type Setting
                        ** is used as a parameter to further specify depending on the data type

DESCRIPTION: These commands are used to obtain current Standard data from the hub. Use
                 the (**sa**) command to access different Standards.

RESPONSE: Responds with the present setting of the selected configuration option. The
                 response varies depending on the option selected. If invalid parameters are
                 provided, then the data returned will be <NONE> or 0's depending on the type of
                 data requested.

**01sg – Get Standard Name.   This returns the current Standard Name string. Up to 40
        characters plus a null terminator. The ** parameters are ignored for the '01' data type.

**02sg – Get Standard Tolerance and Reflectances per Head.   This returns a string of eleven
        numbers, 3 Tolerances and eight Reflectances in the following format
        "aaaaa,bbbbb,ccccc,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx" where each
        number xxxxxx is a WORD in ASCII form (10,000 = 100.00% reflectance). The **
        parameter is to select a head number (1-6). Command will return a Bad Command if the
        parameter is out of range. aaaaa represents the dLED Tolerance, bbbbb for dIntensity,
        and ccccc dColor Tolerances where a value of 100 = 1.00.

**03sg – Get Standard Enable Flag. This returns a flag (0 for disabled, 1 for enabled). The **
        parameter is ignored for this data type.

**04sg – Get Standard Averaging Masks. This returns a string of six averaging masks. The
        format is the same as the Learn Average command. "xx,xx,xx,xx,xx,xx" where each
        number is an ASCII BYTE in hex form. The ** parameter is ignored for this data type.

**05sg – Get Standard Timestamp. This returns an ASCII ULONG number representing the
        timestamp for the current standard. The ** parameter is ignored for this data type.

**06sg – Get Standard Active Tolerances. This returns a string of six values indicating which
        tolerance is active per head. The format received will be "x,x,x,x,x,x". Each value
        determines which tolerance to use. The ** parameter is ignored for this data type. The
        values to use are…
                0 – No Tolerance
                1 – dLED Tolerance
                2 – dIntensity and dColor Tolerances

SERIAL NUMBER (sn)

SYNTAX: **sn**

DESCRIPTION: Returns the current serial number of the Hub.

RESPONSE: **dddddd**
            <00>

            Where: **dddddd** is the present serial number.

STANDARD SET (ss)

SYNTAX: **#**#ss**

            Where: ## is used as a Data Type Setting
                   ** is used as a parameter to further specify depending on the data type

DESCRIPTION: These commands are used to set current Standard data from the hub. Use the
             (**sa**) command to access different Standards.

RESPONSE: Responds with the present setting of the selected configuration option. The
            response varies depending on the option selected.

**01ss – Set Standard Name. After this command is sent to the hub, it expects the Standard
Name to be sent right after. Up to 40 characters plus a null terminator. The **
parameters are ignored for the '01' data type.

**02ss – Set Standard Tolerance and Reflectances per Head. This command is used to set
standard tolerances (first three numbers dLED, dIntensity, and dColor) and reflectances
per head (the following eight). The input string should be the same format that it would
return with the (**sg**) command.
"aaaaa,bbbbb,ccccc,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx,xxxxx" where each
number is a WORD in ASCII form (10,000 = 100.00% reflectance or 100.00 Tolerance).
The ** parameter is to select a head number (1-6). Command will return a Bad
Command if the parameter is out of range.

**03ss – Set Standard Enable Flag. Sets the Enable/Disable flag for the current standard. After
this command is sent the Hub will expect an input of a 0(disabled) of 1(enabled). **
parameter is ignored for this command.

**04ss – Set Standard Averaging Masks. Sets the averaging masks for the current standard.
Expects a string of six averaging masks. The format is the same as the Learn Average
command. "xx,xx,xx,xx,xx,xx" where each number is an ASCII BYTE in hex form. The **
parameter is ignored for this data type.

**05ss – Set Standard Timestamp. The timestamp is generated in software based on the
number of seconds since January 1st, 2000. Expected input after the command is an
ASCII ULONG number. The ** parameter is ignored for this data type.

**06ss – Set Standard Active Tolerances. Sets the active tolerance to use per head. The hub
will expect six values indicating which tolerance is active per head. The format to send is
be "x,x,x,x,x". Each value determines which tolerance to use. The ** parameter is
ignored for this data type. The values to use are… Setting a value for heads that aren't
used will not hurt anything.
>> **0 –** No Tolerance
>> **1 –** dLED Tolerance
>> **2 –** dIntensity and dColor Tolerances

SOFTWARE VERSION (sv)

SYNTAX:　　　**sv**

DESCRIPTION:Returns the hub type and firmware version code. Currently there is only one hub
type.

RESPONSE:　　VC**xxx** v**YYMDD**
　　　　　　　　<00>

　　　　　　　　Where: **xxx** is the Hub Type, 100 (original) or 100B for newer Hub versions
　　　　　　　　　　　　YY is the last two digits of the year (00 – 99).
　　　　　　　　　　　　M is the month (1 – 9 respectively, October = a, November = b,
　　　　　　　　　　　　December = c).
　　　　　　　　　　　　DD is the day (01 – 31).

TARGET HEAD (th)

SYNTAX:　　　##**th**
　　　　　　　　Where: ## is a head number (01-06)

DESCRIPTION: The Hub must already be in Software Targeting Mode (see **hm** command). This
　　　　　　　　command is used to control which Head is measuring. If no parameters are sent,
　　　　　　　　it will return the current targeting head #.

RESPONSE:　　<00> or Bad Command for invalid parameter, or Invalid Head if the requested
　　　　　　　　head doesn't exist.

TARGET LEARN (tl)

SYNTAX:　　　**tl**

DESCRIPTION: This command only works in Software Target Mode. The hub takes the last
　　　　　　　　measurement made by the current head (targeting mode only works with one
　　　　　　　　head at a time) and makes it the Target Standard for all following measurements.
　　　　　　　　Target Standards are remembered while target mode is active, so switching
　　　　　　　　between different heads doesn't require each head to relearn.

RESPONSE:　　<00> if in Software Target mode, Bad Command if not.

VERIFY WHITE CALIBRATION (vw)

SYNTAX:　　　**#vw**

Where: # is a Head Number (1 to 6).

DESCRIPTION: Instructs a single head to perform a white calibration verification test. If no head # is specified, the command returns a bad command response. If the head returns an error code, it will be reflected in the command response.

RESPONSE: <00> if the verify test was successful
<42> if the Verify measurement was outside of its Tolerance.

Appendix A – Error Codes

The following is the list of Base error codes that could appear in a Status packet. The current error log can hold up to twenty unique errors at once. Not all errors get pushed into the error log. When an error is serious enough to get added to the error log, it will have a specific error prefix attached. This allows the user when they check the error log to pinpoint which component is causing problems. For example, during a measurement on a hub with 6 heads, heads 3 and 4 return a "Measurement Failed" error. The hub will return a "<30>" response while in the error log gets two entries "330, 430".

ERROR PREFIXES
HUB ERROR	000
HEAD #1	100
HEAD #2	200
HEAD #3	300
HEAD #4	400
HEAD #5	500
HEAD #6	600

ERROR BASES
NO_ERROR	00
BAD_COMMAND	01
TIMEOUT_ERROR	02
INVALID_HEAD	03
HUB_ERROR_MODE	04
HUB_BUSY	
HEAD_LIST_ERROR	20
MEASUREMENT_FAILED	30
WHITE_CALIBRATION_FAILED	40
BLACK_CALIBRATION_FAILED	41
WHITE_VERIFY_FAILED	42
BLACK_VERIFY_FAILED	43
DATASTORE_LOAD_ERROR	50
MAKE_PERMANENT_ERROR	51

Statuses returned with (ms) command
HEAD_READY_STATUS	60
NO_HEAD_STATUS	61
HEAD_WARMUP_STATUS	62
HEAD_BAD_HARDWARE_STATUS	63