Cooke /i

Communications Protocols

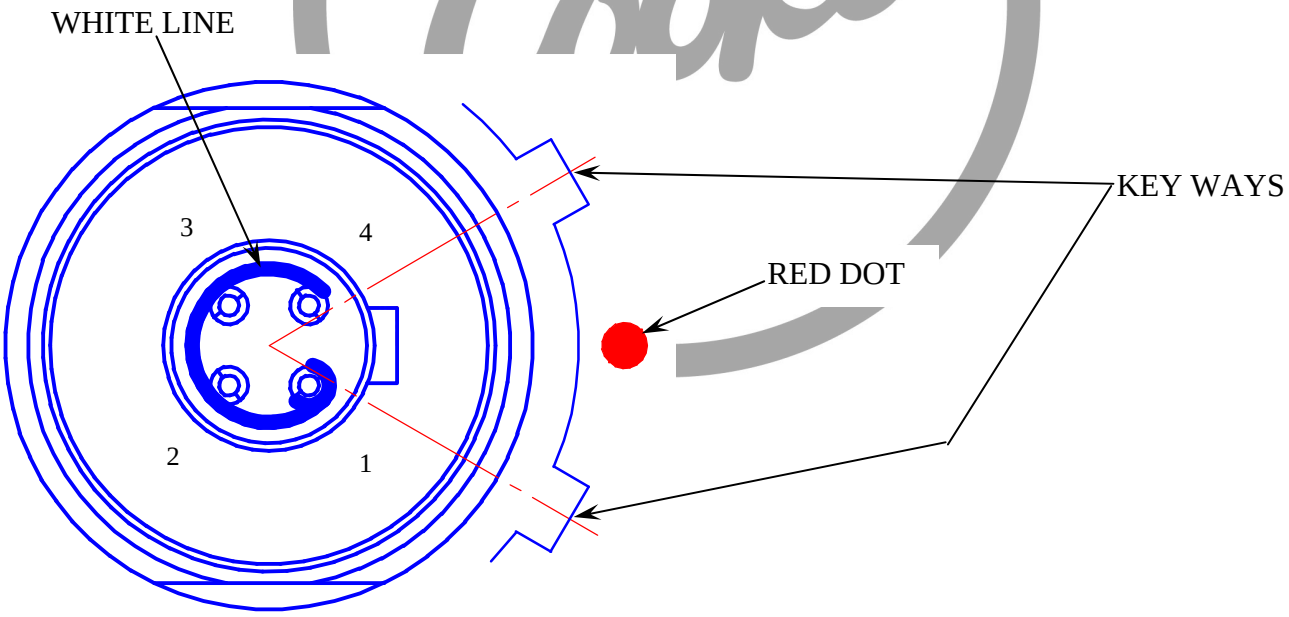
Version 2.28 (/i firmware versions x.x8)
October 2008

Cooke /i Intelligent Electronic Lens System Communication Specification v2.28 – October 2008

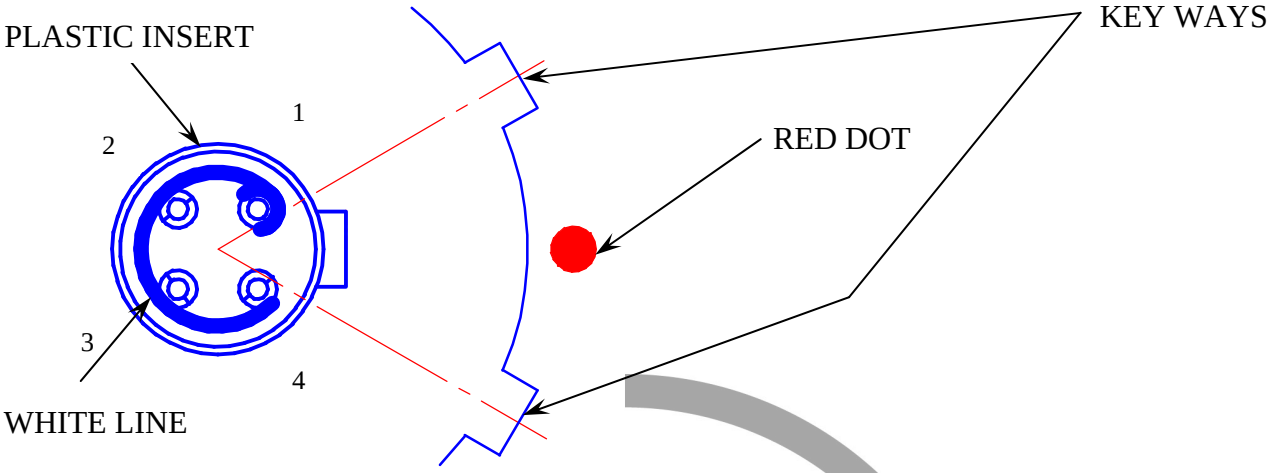
At the introduction of the Cooke /i Intelligent Electronic Lens System the computation power was severely limited due to the availability of miniature micro-processor manufactured at that time. Therefore, early systems used a 10 bit microprocessor and as advances were made in the micro-electronics industry the processor was upgraded to a 12 bit device. This change was adopted as from September 2007 and the 12 bit processor was introduced in a phased manner to all production lenses.

1	**General Operation**
	The system will comprise the following parts: a) Two or three resistance elements with wipers to sense the position of the FOCUS, APERTURE and ZOOM settings of the lens. b) An electronics board that connects to these resistance elements, and also connects to a 4-way connector mounted on the body of the lens. This provides power / serial data (RS232). c) A third connector on the board links to an ARRI camera interface mounted on the PL mount of the lens. This may also provide power and serial data (TTL).
	The lens operating voltage range is +9volts to +35volts DC only. Maximum permitted ripple: < 50mV peak to peak at 100kHz < 50mV peak to peak at 100Hz < 100mV peak to peak of switching spikes. If a ***Bluetooth*** module is used in conjunction with the lens then a minimum of +12volts is required for reliable operation of the ***Bluetooth*** module. The ***Bluetooth*** module is available from Cooke Optics Ltd. (see Appendix C) Power consumption is as follows: S4/i lens only – 100ma max. S4/i lenses coupled with a ***Bluetooth*** module – 200ma max. An external data capture and display unit (to be supplied by others), may be connected to the 4-way connector, or alternatively this may be connected to a PC. The lens may be mounted onto an ARRI camera body AND ALSO to an external unit. This document is general to all types of lenses, but references to ZOOM aspects will only apply to the Zoom lenses.

1.1	**Communication**
	Communication with the lens is from one of two possible channels: 4-way EXTERNAL connector or ARRI connector. Commands to the lens may be received from ONLY ONE of the possible channels, but any data or responses to commands, are transmitted to BOTH communication channels. The 4-way connector is referred to as the EXTERNAL Channel and hence power from this source is known as EXTERNAL Power. Similarly, the ARRI camera interface connector is referred to as the ARRI Channel and power from this source is known as ARRI Power. In addition, a ***Bluetooth*** module may be connected to the External 4-way connector to allow the lens to be used in a wireless mode.
	The connector pin outs are as follows:
	<u>External connector</u> (Lemo socket EGB.00.304.CLL – mating Lemo straight plug FGB.00.304.CLAD35 or mating Lemo elbow plug FHB.00.304.CLAD35). Pin 1 – Data from Lens Pin 2 – Data to Lens Pin 3 – 0 volts Pin 4 – + volts



<u>REAR VIEW OF LEMO SOCKET EGB00304CLL MOUNTED ON THE S4/i LENS.</u>
(This is the view of the solder buckets and the red dot marker and key way positions are indicated for clarity).

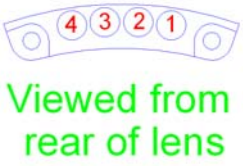


REAR VIEW OF LEMO PLUGS FGB00304CLAD35 OR FHB00304CLAD35 USED TO CONNECT TO THE S4/i LENS.

(This is the view of the solder buckets and the red dot marker and key way positions are indicated for clarity).

Arri connector (Special type hot shoe).

Pin 1 – Data from Lens
Pin 2 – Data to Lens
Pin 3 – 0 volts
Pin 4 – + volts



	The EXTERNAL Channel takes precedence over the ARRI Channel when BOTH are connected. The EXTERNAL Channel operates with RS232 level serial data, while the ARRI Channel operates with TTL serial data. Either or both channels can provide the power to the lens. Diode protection prevents any conflicts with the power source. Calibration and program updates will normally take place via the External Channel.
	Channel Selection / Interlock: To enable the lens to determine which of the two channels has control, the power sources from both channels are monitored. This monitoring takes place at "power-up" to determine if the EXTERNAL Power is present. If EXTERNAL Power is present, then the "receive commands" from the ARRI connector will be inhibited. IF the EXTERNAL Power is NOT present, then the "receive commands" from the EXTERNAL channel will be inhibited. During operation thereafter, the EXTERNAL Power will continue to be monitored for any CHANGE. Should a change take place, this indicates that either the previously connected External unit has been removed, OR that a previously not connected External unit has now been plugged in. If such a change is detected, then a "power on" RESET will occur to establish the current status AND to ensure that the newly connected unit OR the already connected ARRI unit restart.
1.2	**Lens Operation**
	When in use, the electronics will constantly monitor the settings of the separate resistance elements and will use these actual values in conjunction with the calibration data tables to establish the actual setting of the focus, iris and zoom. Where a current potentiometer setting indicates that the setting is between two standard set points, an interpolation will be made to deduce the actual setting. Using these actual values and inbuilt mathematical formulae, a series of calculations is performed, to produce a number of results. These results are available to the External data capture and display unit or the ARRI camera, via the serial EXTERNAL and ARRI channels.
	The External unit or ARRI camera can elect to receive data in either metric or imperial units. It can also elect to receive calculated values for either 16mm OR 35mm film. Whenever a change of film size is made the electronics will respond with the blur circle diameter value associated with that film size. The External unit/ARRI can also elect to receive the updated values on demand (D command) or as a continuous calculate/transmit sequence (see C, H Kd and Kc

	commands). See Section 6 for details of these commands. The current temperature within the lens can also be accessed by the External / ARRI unit.
	An optional checksum can be added to the messages sent from the lens. See section 6.1.4. This checksum can also be turned on/off by external commands. The power-up state is with Checksum off. The protocol for the communications is defined starting at sections 4, 5 and 6.
2	**Data Stored in the Lens Electronics**
	Fixed data stored specifically for each lens will be as follows: Serial Number — 9 characters (see "Note 1" below) Owner data — 31 characters Entrance pupil Position — 4 characters (see "Note 2" below and 6.1.10) Lens type — P (Prime) or Z (Zoom Lens) Calibration — I if imperial, M if metric, B or b if both (see "Note 3" below) Focal length — 3 characters Infinity Nodal distance — 3 characters Calibration table for FOCUS — up to 55 set points – imperial Calibration table for FOCUS — up to 55 set points - metric Calibration Data for APERTURE — up to 55 set points Calibration data for ZOOM — 2 set points Calibration Constants for ZOOM — 36 values Calibration Constants for 150mm and 180mm Prime Lens — 4 values Calibration Constants for Field of View — 2 values
	Note 1: The serial number for prime lenses will take the form 135-0910m. The first group of digits indicates the focal length, (in this example "135mm"). The next four digits indicate the focal length serial number, and the suffix denotes the scale normally fitted to the lens. It is recommended that the suffix is suppressed when the serial number is displayed. The suffix will be one of four options: m Indicates a dual focus scale lens in which the metric scale is normally fitted. i Indicates a dual focus scale lens in which the imperial scale is normally fitted. M Indicates a single focus scale lens that has a metric scale fitted. I Indicates a single focus scale lens that has an imperial scale fitted. **Note: This suffix is NOT used in processing in any way and is used only to**

	designate which scale was on the lens when it shipped from the factory.
	Note 2: The Entrance Pupil Positions for the majority of prime lenses in the S4/i range are fixed static values; however, in the case of the 150mm, 180mm and 300mm lenses, the Entrance Pupil Position is dynamic and varies with focussing distance. The value stored here is the value assigned when the lens is focussed on infinity.
	Note 3: It is the display unit's responsibility to correctly display the lens focus scale output. To aid this, the display units are controlled by the I M B or b character in the 'Fixed Data' field: - If only a valid metric calibration table exists (M), the start-up units will be metric - If only a valid imperial calibration table exists (I), the start-up units will be imperial. - If both imperial and metric calibration tables exist, as in the case of a dual scale lens, then start-up units will be imperial if B or metric if b. Interrogation of the Fixed Data String returned after the issue of an 'N' command at start up will determine which units apply. (See 6.1.10.)
3	**Calculations**
	Since the lens can be used with a camera body utilising different film sizes, appropriate calculations are available, one for each film size. The External display/control unit or Camera will command the lens electronics the select the desired film size. The values measured, calculated and transmitted will be:- Actual Focus distance, Actual Aperture setting, Conventional Aperture setting, Effective Focal Length, Hyperfocal setting, Near focus distance, Far focus distance, Horizontal Field of view, Entrance Pupil Position and Normalised zoom value.
	All distance values output by the lens electronics will be in millimetres or multiples of 0.1 inch. The units / values transmitted will be selected by a command from the External / ARRI unit. The external unit will interpret this data as required, but each value will be with leading zeros included, and be of the number of digits specified in the appropriate message format.

	The Actual Aperture value will be in multiples of 0.01, and the Conventional Aperture will follow the calibrated ring marks, and use the '+n' notation to indicate the nearest 1/10 Stop value. Field of view will be in degrees, to an accuracy of 0.1. Zoom Potentiometer Normalised Value is displayed to an accuracy of 0.001. This normalised value has a range from 1.000 to 0.000 for later software versions only (earlier versions went from 1.00 to 0.00). In the lens data string this value takes the format "zaaaa" – (no decimal point), since "aaaa" will either be 1.000 or 0.aaa. (See 6.1.3.) Entrance Pupil Position units will agree with those used for the focus distance.
	A lens may be calibrated in imperial units only, metric units only, or in both sets of units. The calibration table(s) will be stored into the lens at time of manufacture.
	When the display is selected as IMPERIAL, the following will apply:- a) IF a valid imperial calibration table exists, THEN the Focus distance will be measured and interpolated as imperial. This value will be included in the display string, retaining the imperial units. b) IF only a metric calibration table exists, THEN the measured / interpolated value of Focus distance will be in metric units, but will be converted into imperial for display.
	When the display is selected as METRIC, the following will apply:- c) IF a valid metric calibration table exists, THEN the Focus distance will be measured and interpolated as metric. This value will be included in the display string, retaining the metric units. d) IF only an imperial calibration table exists, THEN the measured / interpolated value of Focus distance will be in imperial units and this will be converted into metric for display.
4	**Communications Protocol** (Note: Spaces are shown between characters to make it easier to read – they ***DO NOT*** appear in the data stream)
	The transfers will be 8 bit data without parity, and will use ASCII format for ease of interpretation by any program such as HYPERTERM. All transfers are initiated by the External unit/ARRI and the Lens electronics will reply with the required information, with the exception of Power up when an automatically generated string is transmitted. ALL replies are sent on both communication channels.

	Messages TO the lens will terminate with a CARRIAGE RETURN character (**C/Ret**), which has the hex value 0D. Reply messages from the lens will terminate with the character pair of LINE FEED **(L/f**) followed by **C/Ret** [hex 0A hex 0D]. All values transferred will be in normal DECIMAL ASCII notation, (unless binary mode Kd or Kc is selected).
	Any message to the lens that is not understood will cause a reply of the character sequence: **? L/f C/Ret** A valid message received will either result in the requested data being sent back, or the reply: **! L/f C/Ret**
5	**Power Up** The power-up sequence will depend on the board configuration and the type of connection being made, either EXTERNAL 4 way or Camera connector. (see appendix B for details).
	Lens Start Up Power-up defaults to 35mm film, checksum off. The display units are controlled by the I / M / B or b character in the 'Fixed Data' field. If only a valid metric calibration table exists (M), the start-up units will be metric. If only a valid imperial calibration table exists (I), the start-up units will be imperial. If both imperial and metric calibration tables exist, then start-up units will be imperial if B or metric if b.
	IF a valid program is NOT loaded, a power message is transmitted as follows: **@ L/f C/ret** If this should occur, contact your service centre or Cooke Optics Ltd.
6	**Valid Message Format**
6.1	**Normal Operation Message Transfers**

6.1.1	Retrieve firmware version. **B C/ret** Response is: **B x x x x L/f C/ret** Where x x x x is the firmware version in the format 0.32. This command is used to determine the currently installed version of firmware and hence determine the facilities available to the user. The expected response would be as indicated: For S4 Prime 10 bit board 0.2X For S4 Prime 12 bit board 0.3X For S4 Zoom 10 bit board 1.2X For S4 Zoom 12 bit board 1.3X For Red Zoom 12 bit board 3.XX
6.1.2	Set Continuous send mode. **C C/ret** Response is: **! L/f C/ret** Once Continuous mode is set the electronics will continually measure, calculate and send the same set of values which would be sent in response to a **D** command. To end Continuous Send mode use the H command Data output rate will be approximately 11 - 43Hz for the 10 bit processor dependent on baud rate and selection of output type. For the 12 bit processor these are amended to 12 – 74Hz dependent on baud rate and selection of output type. (The rates quoted are for prime lenses only).
6.1.3	Request current calculated values: **D C/ret** Response will be: D s s s s s s s T a a a a t b b b b b Z f f f f H a a a a a a a N b b b b b b b F c c c c c c c V v v v . v E s e e e z m m m m S ssssssss l/f c/r Where

	s s s s s s s is the actual focus distance – units a a a a is the actual Aperture setting b b b b b is the calibration ring Aperture value f f f f is the Effective Focal Length –mm *(Note 1)* a a a a a a a a is the HYPERFOCAL setting -units b b b b b b b b is the NEAR FOCUS distance – units c c c c c c c c is the FAR FOCUS distance – units v v v . v is the Horizontal Field of view - degrees s e e e is the Entrance Pupil Position *(Note 2)* m m m m is the normalised zoom setting *(Note 3)* sssssssss is the lens serial number *(Note 4)* The units will depend upon those selected, but will be multiples of 1mm or 0.1 inch. The Hyperfocal, Near and Far focus distances will be calculated for the appropriate film size selection using V, W or Wn commands to set the corresponding Circle of Confusion. (default at power up is for 35 mm). *Note 1*:This field will be 0000 for Prime lenses. *Note 2:*This field consists of a sign (+ /-) and value *Note 3*: this field is only present for zoom lenses. The format is x.xx for firmware version up to and including 1.22,1.30 or 3.02, representing a value in the range 0.00 to 1.00 The format is xxxx for firmware versions 1.23,1.31 or 3.03 onwards, and represents value in the range 0.000 to 1.000 *Note 4*: The field Sssssssss does not appear in firmware versions before 0.21,0.34, 1.22, 1.31 or 3.03 The electronics will monitor the current potentiometer settings and from these calculate the corresponding Focus Distance (S), T stop setting (T), Aperture display value (t) and current Zoom setting (Z and z). From these values, calculation parameters and other constants the electronics will calculate the Hyperfocal (H), Near (N) and Far (F) distances, Horizontal Field of view (V) and Entrance Pupil Position (E) for transmission. The lens serial number is extracted from the FIXED DATA
6.1.4	Set checksum mode. **G C/ret** When received by the lens this command, will set 'Checksum mode'. In this mode, ALL response messages from the lens will have a checksum sequence added, which can be used by the external units to validate the contents of a message. The checksum consists of two characters which are added to the response string between the contents of the message and the termination sequence (L/feed C/ret). The checksum is formed by setting an 8 bit checksum value to all 1's, and then Performing and EXCLUSIVE OR between the existing checksum value and each character of the response string in turn, until the all characters are processed. The

	resulting 8 bit checksum is then converted into two separate characters as follows: Checksum value c7 c6 c5 c4 c3 c2 c1 c0 First checksum character for transmission is: 0 1 0 0 c7 c6 c5 c4 Second checksum character for transmission is: 0 1 0 0 c3 c2 c1 c0 These two characters are appended to the response string and then the terminator characters are appended (L/feed C/ret). Note that the checksum characters cannot be confused with the termination sequence. To unset checksum mode, the **H** command is used. The power-on state of the lens is with checksum mode OFF.
6.1.5	Stop continuous-send mode. **H C/ret** Response is: **! L/f C/ret** This is used to cease transmission of the data string after either C or Kc commands. It will also unset the G, Checksum command and the Ka, inhibit error response command.
6.1.6	Select Inhibit Error Responses **Ka C/ret** Response is **!l/f C/ret** When this mode is set any incorrect commands or invalid messages to the board will be ignored. This mode may be unset by the H command.
6.1.7	Select Revised Baud Rate **K b n C/ret** This command is used when the data transfer speed is required to be altered. The value of "n" indicates the new baud rate to be adopted. The values for n are :- Provisional

	"n" Value	Baud rate	Baud rate Error Prime	Baud rate Error Zoom	Maximum cable length	Maximum Refresh Rates 10 bit Kc	10 bit C	12 bit Kc	12 bit C
	0	set to 9600	0.16%	0.16%	50 metres	16Hz	11Hz	20Hz	12Hz
	1	set to 19200	0.16%	0.16%	30 metres	24Hz	17Hz	33Hz	21Hz
	2	set to 38400	1.36%	0.16%	10 metres	33Hz	25Hz	50Hz	35Hz
	3	set to 48000	0.16%	0.16%	8 metres	35Hz	28Hz	56Hz	41Hz
	4	set to 57600	1.36%	0.94%	5 metres	37Hz	30Hz	60Hz	45Hz
	5	set to 96000	0.16%	0.16%	2 metres	41Hz	36Hz	71Hz	58Hz
	6	set to 115200	1.36%	1.36%	2 metres	43Hz	38Hz	74Hz	62Hz

Please note that the selected data rate WILL have a minor error compared to the defined rate. Also there will be cable drive length limitations, which will depend upon speed. See list above for baud rate error and provisional maximum cable length. The maximum refresh rates quoted are for prime lenses when using the Kc and C commands. A zoom lens has a rate similar to those stated for a prime lens.

When changing the baud rate, a valid speed change will result in the standard good response of **K b n ! Lf C/ret**, which will be sent by the lens BEFORE the speed is altered. The value of "n" will be as the command request.
Once this response has been sent, the lens will change to the new speed.

IF a Bluetooth module is connected to the lens, the commands will be treated as invalid and the **? Lf C/ret** response will be issued, and the speed will remain at 9600 baud.

6.1.8 Set Continuous Send of Full data in Binary Mode **K c C/ret**

This command is used to alter the displayed data format to Binary, but with all calculations still being performed. The data content is the same as that for the Kd command (6.1.9), Data is ALWAYS sent in continuous mode. This mode is unset by using the H command.

6.1.9 Request to Send of Full Data in Binary mode **K d C/ret**

This command is used to alter the displayed data format to Binary, but with all calculations still being performed. The data content is the same as that for the D command, but the values are in binary form to reduce data transfer time. (See Appendix A for details of data string construction and decoding).

The format of the data packet is :-

d ssss TT tt zz hhhh nnnn ffff vv ee ZZ Sssssssss l/f c/r

Where:-

d is the single character indicating packet start.

ssss	Focus distance	
TT	Aperture value	
tt	Aperture scale setting	
zz	Effective focal length (0 for Prime lens)	
hhhh	Hyperfocal distance	
nnnn	near focus distance	
ffff	Far focus distance	
vv	Horizontal field of view	
ee	Entrance Pupil position	
ZZ	Normalised zoom value	*(Note 1)*
Sssssssss	Lens serial number	*(Note 2)*

Where :-

ssss, hhhh, nnnn and ffff are all 24 bit binary values packet into 4 bytes as follows:-

0 1 b23 b22 b21 b20 b19 b18
0 1 b17 b16 b15 b14 b13 b12
0 1 b11 b10 b09 b08 b07 b06
0 1 b05 b04 b03 b02 b01 b00

A binary value of all 1's is treated as infinity.

The value TT is a 12 bit value in 2 characters:-

0 1 b11 b10 b09 b08 b07 b06
0 1 b05 b04 b03 b02 b01 b00 ***range 144 to 2560 (1.44 to 25.60) *******

tt is 2 characters which contain the Aperture Ring T stop integer x 10 and the 1/10th fraction.

1 b6 b5 b04 b03 b02 b01 b00 ***Range 14 to 220 for integer x 10*******
1 b7 0 0 b03 b02 b01 b00 Range 0-9 for $1/10^{th}$ fraction.

zz is the 10 bit value in 2 characters

0 1 0 0 b09 b08 b07 b06
0 1 b05 b04 b03 b02 b01 b00 range 0 to 1023

vv is the 11 bit value in 2 characters (multiples of 0.1 degrees):-

0 1 0 b10 b09 b08 b07 b06
0 1 b05 b04 b03 b02 b01 b00 range 0 to 1800 (0.0 to 180.0)

ee is the signed 10 bit value in 2 characters.

0 1 s 0 b09 b08 b07 b06 s =0 for positive, s=1 for negative
0 1 b05 b04 b03 b02 b01 b00 range 0 to 1023

	Note 1. This field is NOT included in Prime lens data string For firmware version up to and including 1.21, 1.30 or 3.02:- Z is the 7 bit value 1 b6 b05 b04 b03 b02 b01 b00 range 0 to 100 (0.00 to 1.00) For firmware version 1.22,1.31, 3.02,4.01 or 5.01 and later:- ZZ is the 10 bit value packed into 2 characters as follows:- 0 1 0 0 b09 b08 b07 b06 0 1 b05 b04 b03 b02 b01 b00 range 0 to 1023 (0.000 to 1.000) *Note 2*: The field Sssssssss does **not** appear in firmware versions **before** 0.21,0.34, 1.22, 1.31 or 3.03

6.1.10	Read fixed data. **N C/ret** The response expected from a Zoom lens differs from that expected from a Prime lens. The responses are given below. **N c/r Read Fixed Data** ***Response for S4 Prime lens*** **N S s .. s s s s O u ……u ……..L t f x x x N d d d U b E seee y l/f c/r** *Software version 0.25 onwards or 0.35onwards* **N S s .. s s s s O u ……u ……..L t f x x x N d d d U b E seee Bv.vv l/f c/r** ********** ***Response for S4 Zoom lens*** **N S s .. s s s s O u ……u …….. L t N x x x M d d d U b T f f yyy l/f c/r** *Software version from 1.26 onwards or 1.36 onwards* **N S s .. s s s s O u ……u …….. L t N x x x M d d d U b T f f yy Bv.vv l/f c/r** ********** ***Response for Red Zoom lens*** *Software version up to 3.02* **N S s .. s s s s O u ……u …….. L t N x x x M d d d U b T f f yyy l/f c/r** *Software version 3.03* **N S s .. s s s s O u ……u …….. L t N x x x M d d d U b T f f yyy Bv.vv l/f c/r** *Software version 3.06 onwards* **N S s .. s s s s O u ……u …….. L t N x x x M d d d U b T f f yy Bv.vv l/f c/r**

The Fixed data fields for each lens are as follows:-

For S4 Prime lenses:-

sssss..ss	Serial Number	9 characters (any printable ascii character)
uuu..uu	Owner data	31 characters (any printable ascii characters)
t	lens type	P
xxx	Focal length	3 characters 004 to 305 *(Note 1)*
Nddd (or nddd)	Infinity Nodal distance-	sign (N/n) and 3 digits (-300 to +300)
b	Calibration	I if Imperial, M if metric, B or b if both *(Note2)*
seee	Entrance pupil Position	sign plus 3 characters
y	Packing character	undefined
v.vv	software version issue	

For Zoom lenses:-

sss..ss	Serial Number	9 characters (any printable ascii character)
uuu..uu	Owner data	31 characters (any printable ascii characters)
t	Lens type	Commencing at "A" for 18-100 Zoom Lens
xxx	Minimum Focal length	3 characters 004 to 100
ddd	Maximum Focal Length	3 characters 010 to 500
b	Calibration	I if Imperial, M if metric, B or b if both *(Note2)*
ff	Transmission factor	2 digits (00 to 99)
yy or yyy	Packing characters	undefined
v.vv	software version issue	

Note 1: Allows for additional types of lens e.g. 4mm focal length, but with a maximum of 305 mm. Focal lengths can only be integer values.

Note 2: This character defines which Calibration tables are valid (Imperial or Metric), and where both are valid, which is the current power on selection of units for display (B = imperial) or (b= metric). Where both tables are valid, the X and Y commands will alter this value accordingly.

Note. If the lens is in the READY state and any command other than N C/ret is transmitted then the lens will only respond by re-issuing the < prompt.

6.1.11	Retrieve lens temperature. **P C/ret** Response is: **x x L/f C/ret** Where x x is the current temperature to the nearest degree Celsius. To read the temperature takes up to 2 seconds. Reading the temperature should be undertaken relatively infrequently as the process will inhibit the correct reading / sensing of the Focus, Aperture and Zoom positions, and also inhibit the calculation process.
6.1.12	Select 35mm film. **V C/ret** Response is: **V 0 . 0 b b b L/f C/ret** Where 0.0 b b b is the 35 mm blur circle diameter in mm.
6.1.13	Select 16mm film. **W C/ret** Response is: **W 0 . 0 b b b L/f C/ret**
6.1.14	**W n n c/r Select film size.** Response is **W 0 . 0 b b b l/f c/r** Where 0.0 b b b is the corresponding blur circle diameter or Circle of Confusion value in mm. The range of values for nn is currently limited to 00 to 06 as follows:- **00 35 mm** **01 16 mm** **02 4096 x 2304 – RED 4k** **03 3072 x 1728 – RED 3k** **04 2048 x 1152 – RED 2k** **05 AATON 3 perf** **06 AATON 2 perf** **07 4480 x 1866 – RED 4.5k** **08 2764 x 2304 – RED 4k Anamorphic** As further film size selections are required, the valid range will increase and associated values allocated. Currently values W07 and above will return an error response. Note: this command is available from version x.x7 onwards.
6.1.15	Set selected units imperial. **X C/ret**

	Response is: **X L/f C/ret** The current focus distance and all distance units will now be displayed as imperial. If the lens has both imperial and metric calibration tables set, then the 'Start up units' character in the Fixed Data will be forced to 'B', to ensure that at subsequent applications of power the units setting is also imperial. If the lens has a single metric scale only, then only the current focus distance units will change to imperial but the 'Start up units' will be unaffected and remain as metric.
6.1.16	Set selected units metric. **Y C/ret** Response is: **Y L/f C/ret** The current focus distance and all distance units will now be displayed as metric. If the lens has both imperial and metric calibration tables set, then the 'Start up units' character in the Fixed Data will be forced to 'b' to ensure that at subsequent applications of power the units setting is also metric. If the lens has a single imperial scale only, then only the current focus distance units will change to metric but the 'Start up units' will be unaffected and remain as imperial.
7	**Program Update**
	<u>Update the Stored Program from an External Source</u> It will be possible to update the stored program from an external source, provided the correct security sequence is used, as this is a potentially dangerous facility. A "BOOT LOADER" section of program will always exist that is capable of downloading the "new program". The Boot loader will not allow itself to be overwritten. Consult your service centre or Cooke Optics for details.
8	**Summary of letter commands used:**
	<u>Standard Command Set</u> B request current firmware revision C set Continuous transmit mode D request current Data values G set checksum mode H Halt continuous transmit mode Ka Inhibit error responses Kb Select Revised Baud Rate Kc Set Continuous Send of Full data in Binary Mode Kd Request to Send of Full Data in Binary mode N read leNs fixed data P Read current temperature of lens

	V set thirty fiVe mm W set Sixteen mm Wnn set special format X set units to imperial Y set units to metric ***Bluetooth*** Command Set AT Search for ***Bluetooth*** module ATZ ***Bluetooth*** module present AT+BTINQ? Request for ***Bluetooth*** module and Lens identification AT+BTCANCEL Abort request for ***Bluetooth*** module and Lens identification ATDxxxxxxxxxxxx Establish ***Bluetooth*** link with ***Bluetooth*** module xxxxxxxxxxxx where xxxxxxxxxxxx is the 12 digit unique reference code.
	Calculation / Message Response Times
	The response time to provide any requested data will vary but is anticipated that the maximum delay will be 1.0 seconds during normal operation. This delay MAY increase during calibrate or diagnostic sequences, or at extreme point of a potentiometer, or during a temperature read.
10	**Future Additional Features**
	S4/i Communications Protocol is a live and flexible document. As such, additional features will be added as the industry identifies their needs and requirements. This will undoubtedly result in the addition of extra commands and may ultimately increase/decrease the length of the output data string. All users should ensure that their equipment has the capability of readily adjusting to these additional features of which the user group will be kept fully informed. We recommend that all S4/I lens users load the latest firmware into each S4/i lens to get the maximum benefit from the features provided.

APPENDIX A

Binary packing of data with the Kd command to reduce transmission time.

The standard data as transmitted by the lens in response to the D command is also transmitted in response to the Kd command. The difference is in the way the data is packed.

With the D command, all the data values are in standard ASCII format characters, which can easily be interpreted by many programs, in particular a simple Communications package used on the PC such as Hyperterm. All characters are standard ASCII, terminated with the standard L/feed C/ret combination.

The standard Data string also includes separators to distinguish between successive values. A standard D response from a Prime lens is :-

D s s s s s s s T a a a a t b b b b b Z f f f f H a a a a a a a a N b b b b b b b b F c c c c c c c c
V v v v . v E s e e e S ssssssss l/f c/r

And from a Zoom lens is:-

D s s s s s s s T a a a a t b b b b b Z f f f f H a a a a a a a a N b b b b b b b b F c c c c c c c c
V v v v . v E s e e e z m m m m S ssssssss l/f c/r

Where the BOLD / ITALIC characters highlighted are the separator / markers.

The content of the “values” within the string are defined within section 6.1.1 of the specification.

The above strings will be of length 70 characters for Prime and 75 for zoom lenses (including the L/feed / Cret terminators).

To reduce the time taken to transmit the information, an additional packing format is available – this is the packed binary mode (Kd command). The SAME information is transmitted by the lens, but the format is different as follows:-

dssssTTttzzhhhhnnnnffffvveeSssssssss for Prime lenses,

And :-

dssssTTttzzhhhhnnnnffffvveeZZSssssssss for Zoom lenses.

These strings contain 39 characters for Prime lenses and 41 for zoom lenses (again including L/feed C/ret terminator). The single ***d*** denotes the start of the string and is a standard ASCII d character code (hex 64).

The method chosen to form the data in to the "packed binary" format has been selected to a) enable Hyperterm to still be used as a simple viewer of output, and b) to ensure that the termination sequence CANNOT appear within the data values.
To achieve this, every 8 bit character sent, will ONLY use either 6 or 7 bits as a value or part value, with one of the remaining bits being set to 1.

To demonstrate the principle, the following will be a data string generated by the D command, followed by the SAME data set as string from the Kd command. The way the strings are built will be then explained.
Note this is for a PRIME lens.

D0000388T0849t 8+2Z0000H0001243N0000309F0000532V045.5E+037S40-0921

Focussing distance is 0000388

True Aperture	08.49
Displayed Aperture	8 + 2/10's
Zoom	0000
Hyperfocal setting	0001243
Near Focus	0000309
Far focus	0000532
Field of view	045.5
Entrance Pupil	+037
Serial Number	40-0921, (40mm focal length lens serial number 092 . Note serial number may not always fill the full 9 characters allowed – any missing characters will be filled using spaces).

d@@FDMQ؟é@@@@S[@@Du@@HTGG@e (as displayed by Hyperterm).

(The font selected in Hyperterm must be Terminal to ensure easier conversion between ASCII and binary values).

d			= Binary Value 01100100
Focussing distance is	@@FD	(ssss)	= Binary Value 01000000010000000100011001000100
True Aperture	.MQ	(TT)	= Binary Value 0100110101010001
Displayed Aperture	ÁÉ	(tt)	= Binary Value 1010100010000010
Zoom	@@	(zz)	= Binary Value 0100000001000000
Hyperfocal setting	@@S[	(hhhh)	= Binary Value 01000000010000000101001101011011
Near Focus	@@Du	(nnnn)	= Binary Value 01000000010000000100010001110101
Far focus	@@HT	(ffff)	= Binary Value 01000000010000000100100001010100
Field of view	GG	(vv)	= Binary Value 0100011101000111
Entrance Pupil	@e	(ee)	= Binary Value 0100000001100101
Serial Number	40-0921		= Binary Value 001101000011000000101101
			001100000011100100110010001100011
			0100100100100000

The complete data string in binary is given below. (Note the commas are not in the data string and are shown to aid decoding in this example).

01100100, 01000000010000000100011001000100, 0100110101010001, 1010100010000010, 01000000010000000100000001000000, 01000000010000000101001101011011, 01000000010000000100010001110101, 01000000010000000100100001010100, 0100011101000111, 0100000001100101, 00110100001100000010110100110000001110010011001000110001010010010000 0

Each of the values for Focussing distance, Hyperfocal setting, Near Focus and Far focus is presented in the D format as 7 characters with leading zeros. These values are stored inside the lens as 24 bit (3 x 8 bit byte) values.

To transmit in the D mode, the 24 bit value is converted into decimal ASCII for transmission. For the Kd mode, it is packed in a different manner as follows:-

(Using the example above)

Focussing distance	388	= binary	00000000 00000001 10000100
Hyperfocal setting	1243	= binary	00000000 00000100 11011011

The 24 bits of binary are re-grouped into sets of 6 bits.

Focussing distance	000000	000000	000110	000100
Hyperfocal setting	000000	000000	010011	011011

Each of these groups of 6 bits has 2 extra bits of 01 added at the beginning to form:-

01000000	01000000	01000110	01000100
01000000	01000000	01010011	01011011

These “characters” or groups of 8 bits are then transmitted, and when received by Hyperterm, they will be “interpreted” as being ASCII characters to enable them to be displayed by a symbol which corresponds to that binary pattern. Thus the codes will be :-

01000000	@
01000000	@
01000110	F
01000100	D

01000000	@
01000000	@
01010011	S
01011011	[

The packing method for the other fields follows a SIMILAR principle, BUT there are differences.

The True Aperture field has only 2 “characters” to represent a 12 bit value:-

01xxxxxx
01xxxxxx

The Displayed Aperture value also has 2 “characters”, but these are packed differently:-

1xxxxxxx
1x00yyyy Where xxxxxxxx is an 8 bit Aperture STOP x10, and yyyy is a 1/10 value (0 to 9)

The Zoom field is 2 “characters” which hold 10 bits:-

0100xxxx
01xxxxxx

The Field of View has 2 “characters” for a 12 bit value:-

01xxxxxx
01xxxxxx

The Entrance Pupil Position has 2 “characters” to hold a SIGNED 10 bit value:-

01S0xxxx
01xxxxxx

Using the example above for an Entrance pupil position of +037, this will exist as a 10 bit value plus sign stored in binary as:-

Sign, (000000)00 00100101

(note it will occupy 2 bytes for the 10 bits).

When repacked, this will give: (00)0000 100101

The 01 bits are added, as is the sign ([0] for + and [1] for -) to give

01 [0] 0 0000
01 100101

these are transmitted and will be displayed as :-

01000000	@
01100101	e

The Normalised Zoom Value, (NZV), is only transmitted in the zoom lens string and is two “character2” which holds a 10 bit value:-

0100 xxxx
01xx xxxx Where xxxx is the most significant bit and
xx xxxx is the least significant bit.

The Normalised Zoom Value varies between 0.000 and 1.000 depending on the zoom scale setting.

The Serial Number “characters” or groups of 8 bits are transmitted, and when received by Hyperterm, they will be “interpreted” as being ASCII characters to enable them to be displayed by a symbol which corresponds to that binary pattern. Thus the codes will be :-

00110100	4
00110000	0
00101101	-
00110000	0
00111001	9
00110010	2
00110001	1
01001001	I
00100000	SPACE – issued to fill character space.

The ASCII codes for Line feed and Carriage return are 00001010 and 00001101, thus it is impossible (unless data corruption occurs), for either of these codes to appear within the series of data values in the packed binary mode.

APPENDIX B

Firmware versions and Board Configurations

Contents:-

The command **KF c/r** can be used to retrieve the Base firmware version, the response being:- **fx l/f c/r** where x represents the base firmware installed.

The command **B c/r** can be used to retrieve the version of software/firmware installed. The response is:- **B a b c d l/f c/r** where abcd represents the version installed.
The convention used is that the first character "a" denotes the board type and "cd" represents the issue.

For S4 Prime 10 ADC bit boards "abcd" will be 0.0x,0.1x or 0.2x
For S4 Prime 12 ADC bit boards "abcd" will be 0.3x
For S4 Zoom 10 ADC bit boards "abcd" will be 1.2x
For S4 Zoom 12 ADC bit boards "abcd" will be 1.3x
For Red 12 ADC bit boards "abcd" will be 3.0x

Summary table of base firmware software issues.

S4 Prime 10 ADC bit boards	e,f,g	0.05 .. 0.27
S4 Prime 12 ADC bit boards	h,i,j	0.30 .. 0.37
S4 Zoom 10 ADC bit boards	v,w	1.21 .. 1.27
S4 Zoom 12 ADC bit boards	p,q	1.30 .. 1.37
Red 12 ADC bit boards	r,s	3.02 .. 3.07

1 S4 Prime series boards 10 bit ADC.

This board has 2 communications channels, the External one being RS232, and the Camera is TTL. The External Interface takes precedence over the Camera interface IF power is supplied through both connectors. If only one connector supplies power, it will be the active channel.

Two potentiometers are connected through a single 4 way connector. This connector supplies +5v and 0v to the potentiometers, which are used to sense Aperture and Focussing Distance.

The start-up sequence depends upon which channel is being used for control. If the Camera channel is valid, then start-up will be at 9600 baud without timeout on receiving an N command.
If the External channel has control, initial start-up will be at the higher speed of 115k2 baud. If an N command is received within 1 second, operation will continue at this speed. If no N command is received, then speed will drop to 9600, and the prompt for Bluetooth operation will be sent. If an N command is received within 1 second, then operation moves immediately to direct connection at 9600 baud. If the correct exchange sequence occurs, then a Bluetooth link at 9600 baud is established, which will be at fixed speed.

The current versions of the base firmware is version “e”, “f” or “g”

The current versions of the software installed into the boards are as follows:-

V0.05 to 0.19 Early versions – most do not exist.
V0.20
V0.21 Addition of Serial number to lens data string.
V0.22 -addition of Ka command.
V0.22-25 skipped
V0.26 add board software version to end of Fixed data string for N command.
V0.27 allow for further film formats (Wn commands)
V0.28 add formats to the Wnn command

2 S4 Prime series boards 12 bit ADC.

This board has 2 communications channels, the External one being RS232, and the Camera is TTL. The External Interface takes precedence over the Camera interface IF power is supplied through both connectors. If only one connector supplies power, it will be the active channel.

Two potentiometers are connected through a single 4 way connector. This connector supplies +5v and 0v to the potentiometers, which are used to sense Aperture and Focussing Distance.

The start-up sequence depends upon which channel is being used for control. If the Camera channel is valid, then start-up will be at 9600 baud without timeout on receiving an N command.
If the External channel has control, initial start-up will be at the higher speed of 115k2 baud. If an N command is received within 1 second, operation will continue at this speed. If no N command is received, then speed will drop to 9600, and the prompt for Bluetooth operation will be sent. If an N command is received within 1 second, then operation moves immediately to direct connection at 9600 baud. If the correct exchange sequence occurs, then a Bluetooth link at 9600 baud is established, which will be at fixed speed.

The Processor on this board has been upgraded from the 10 bit ADC version, and has faster operation and increased resolution for the ADC, but otherwise is functionally identical.

The current versions of the base firmware is version “h”,“i” or “j”

The current versions of the software installed into the boards are as follows:-

V0.30/31
V0.33 Operation as per v0.21 including E command
V0.34 - Addition of Serial number to lens data string
V0.35 addition of Ka command,
V0.36 add board software version to end of Fixed data string for N command.
V0.37 allow for further film formats (Wn commands)
V0.38 add formats to the Wnn command

3 S4 Zoom series boards 10 bit ADC.

This board has 2 communications channels, the External one being RS232, and the Camera is TTL. The External Interface takes precedence over the Camera interface IF power is supplied through both connectors. If only one connector supplies power, it will be the active channel.

Three potentiometers are connected through two 4 way connectors. These connectors supply +5v and 0v to the potentiometers, which are used to sense Aperture, Focussing Distance and Zoom.

The start-up sequence depends upon which channel is being used for control. If the Camera channel is valid, then start-up will be at 9600 baud without timeout on receiving an N command.
If the External channel has control, initial start-up will be at the higher speed of 115k2 baud. If an N command is received within 1 second, operation will continue at this speed. If no N command is received, then speed will drop to 9600, and the prompt for Bluetooth operation will be sent. If an N command is received within 1 second, then operation moves immediately to direct connection at 9600 baud. If the correct exchange sequence occurs, then a Bluetooth link at 9600 baud is established, which will be at fixed speed.

The current versions of the base firmware is version “v” or “w”

The current versions of the software installed into the boards are as follows:-

V1.21 .
V1.22 .
Addition of Serial number to lens data string.
Increase Normalised zoom resolution.
V1.23 -addition of Ka command
V1.23-25 skipped
V1.26 add board software version to end of Fixed data string for N command.
V1.27 allow for further film formats (Wn commands)
V1.28 add formats to the Wnn command

4 S4 Zoom series boards 12 bit ADC.

This board has 2 communications channels, the External one being RS232, and the Camera is TTL. The External Interface takes precedence over the Camera interface IF power is supplied through both connectors. If only one connector supplies power, it will be the active channel.

Three potentiometers are connected through two 4 way connectors. These connectors supply +5v and 0v to the potentiometers, which are used to sense Aperture, Focussing Distance and Zoom.

The start-up sequence depends upon which channel is being used for control. If the Camera channel is valid, then start-up will be at 9600 baud without timeout on receiving an N command.
If the External channel has control, initial start-up will be at the higher speed of 115k2 baud. If an N command is received within 1 second, operation will continue at this speed. If no N command is received, then speed will drop to 9600, and the prompt for Bluetooth operation will be sent. If an N command is received within 1 second, then operation moves immediately to direct connection at 9600 baud. If the correct exchange sequence occurs, then a Bluetooth link at 9600 baud is established, which will be at fixed speed.

The Processor on this board has been upgraded from the 10 bit ADC version, and therefore has increased resolution for the ADC, but otherwise is functionally identical.

The current versions of the base firmware is version “p”or “q”

The current versions of the software installed into the boards are as follows:-

V1.31
- Addition of Serial number to lens data string.
- Increase Normalised zoom resolution.
- Addition of Ka command

V1.31-35 skipped
V1.36 add board software version to end of Fixed data string for N command.
V1.37 allow for further film formats (Wn commands)
V1.38 add formats to the Wnn command

5 Red Zoom board 12 bit ADC.

This board has a single communications channel for the Camera, and operates at TTL levels.

Three potentiometers are connected through a single 5 way connector. This connector supplies +5v and 0v to the potentiometers, which are used to sense Aperture, Focussing Distance and Zoom.

The start-up for this board is at 115k2 baud, and if an N command is received within 1 second, operation continues at this speed. If no N is received, the speed is dropped ton 9600 baud, and the board waits without timeout for an N command.

The Processor on this board uses a 12 bit ADC. The current versions of the base firmware is versi

The current versions of the software installed into the boards are as follows:-

V3.02

Note that the v2 and v1 fields of the R command response are 0000.

V3.03 .

Addition of Serial number to lens data string.
Increase Normalised zoom resolution.
Addition of Ka command
Addition of software version to the end of the Fixed data string in response to an N command.

V3.04-05 skipped

V3.06 remove 1 packing character from N response field (to make same length as all other board responses.

V3.07 allow for further film formats (Wn commands)

V3.08 add formats to the Wnn command

Firmware Version Naming Convention.

In line with the high level of customer care that is a part of the Cooke Optics tradition, the lens firmware has recently been further developed to aid the tasks of the film crew and also the post process laboratory operatives. The rate of the data output has been much enhanced such that film frame speed compatible data is now available. To coincide with this improvement the firmware version numbers have been revamped to reflect the issue of the communications specification. Thus the version numbers that now apply are as follows:-

Communications Specification – 2.27

Program Updater - 1.1.0.0

Prime Lens Firmware (10 bit) - 10_0.27
Prime Lens Firmware (12 bit) - 12_0.37

Zoom Lens Firmware (10 bit) - 10-1.27
Zoom Lens Firmware (12 bit) - 12_1.37

Red Zoom (12 bit) 3.07

We recommend that users of Cooke /i lenses update their firmware/software to reflect the version numbers noted above.

APPENDIX C

Blue tooth Operation (S4I only)

If a ***Bluetooth*** module is present in the power line then the device will respond with "***Bluetooth*** Module Present" (**ATZ C/Ret**) and the module status LED will change from STEADY AMBER to FLASHING GREEN. The lens response will be of the format:

AT+BTSCAN=Cooke S4I Ser No.135-0902I

The ***Bluetooth*** module will now await interrogation from the intended mating command ***Bluetooth*** transmitter.
To establish the wireless communication link the command transmitter will issue the message:

AT +BTINQ? C/RET

The lens will typically respond via the ***Bluetooth*** wireless link with a message of the format:

000B531622E0, Cooke S4I Ser No 135-0902I,001F00 L/f C/ret
OK L/f C/Ret

(If there are other active ***Bluetooth*** devices, including additional ***Bluetooth*** powered S4i lenses, they will also be listed at this point).

To complete the wireless communication link, the mating ***Bluetooth*** command transmitter will now select the first 12 digits from the lens response and incorporate them in a message of the format:

ATD000B531622E0 L/f C/Ret

(Note the first 12 digits are the unique code for the ***Bluetooth*** module, thus each module will have its own unique 12 digit code).

The lens response will be:

OK L/f C/Ret
CONNECT00B5321622E0 C/Ret
< L/f C/ret

The S4i ***Bluetooth*** module status LED will now change from FLASHING GREEN to STEADY GREEN.
The mating ***Bluetooth*** command transmitter may now issue the "Request for Fixed Data", (**N C/Ret**). The lens will return the response detailed in 6.1.9.