June 16, 1999

1. INTERFACE

1.1. COMMUNICATION PROTOCOL

1.1.1. Serial Communication between the Host and the 3810 series camera is based on the RS-232C standard. The following shows the main communication parameters.

Mode	Half-Duplex, Unsynchronized
Data Span	8 bit
Start Bit	1 bit
Stop Bit	1 bit
Baud Rate	9600 bps
Parity	N/A

1.2. CONNECTIONS

Host PC (9 pin D-Sub, Female)			3810 Series Camera (9 pin D-Sub, Female)	
PIN #	SIGNAL	DIRECTION	SIGNAL	PIN #
3	TXD	→	RXD	2
2	RXD	←	TXD	3
5	GND	—	GND	5

NOTE: Unless indicated otherwise, all parameters are HEX values.

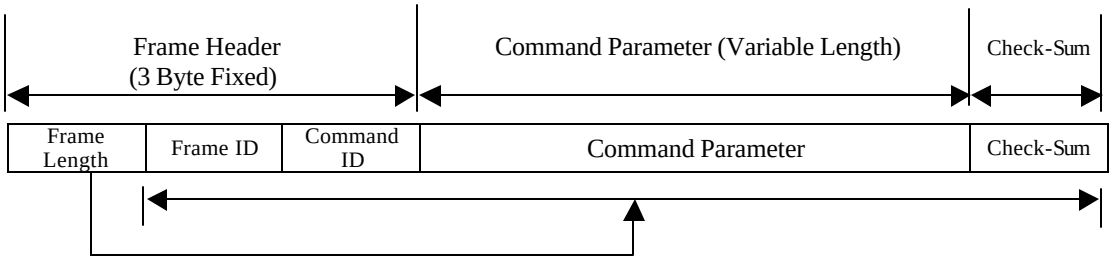
2. FRAME FORMAT

2.1. This section describes the frame format for the serial communication that is transferred between the Host and the 3810 series camera.

2.2. There are two types of frames, the Command Frame, and the ACK/NACK frame.

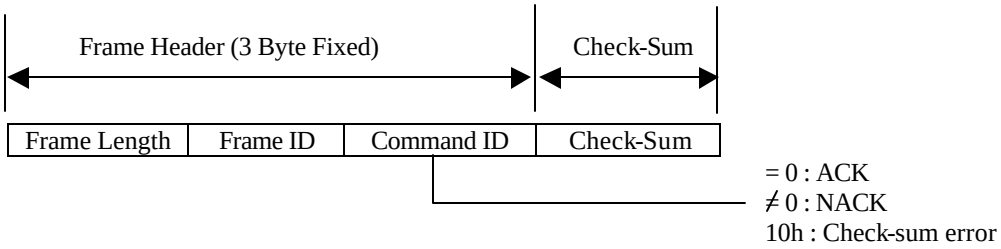
2.3. The Command Frame is composed of a Frame-Header, a variable length Command Parameter, and a Check-sum.

2.3.1. Command Frame Composition



2.4. ACK/NACK Frame is fixed at four bytes, and is composed of a 3 byte Frame-Header, and a Check-sum.

2.4.1. ACK/NACK Frame Composition



3. CHECK-SUM

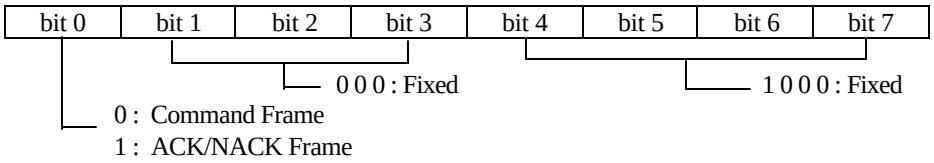
3.1. The value of the check-sum is set so that the sum of all of the components of the frame, including the check-sum, equals zero.

4. FRAME HEADER FORMAT

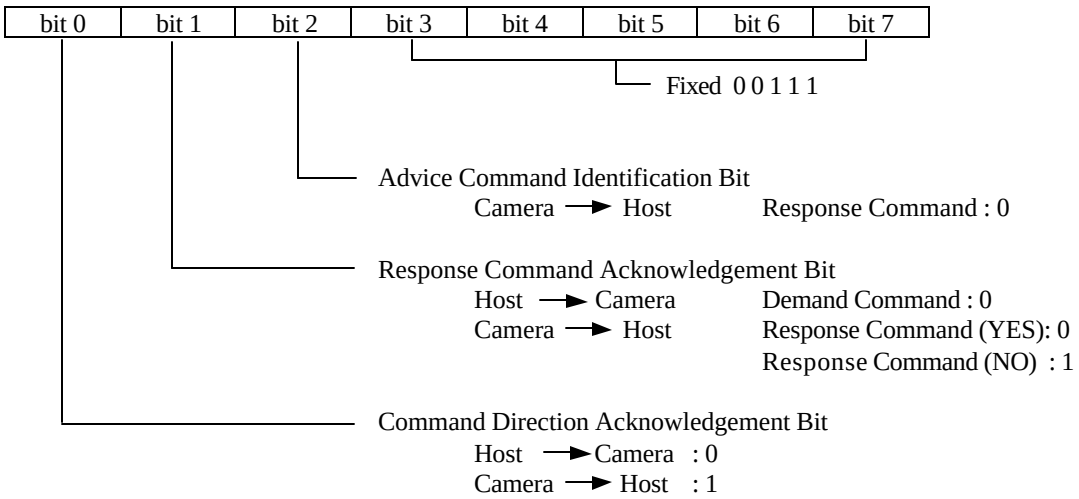
4.1. The Frame-Header is composed of three bytes, the Frame Length, the Frame ID, and the Command ID.

4.2. FRAME LENGTH: Identifies the total number of bytes in the frame, including the Check-sum. The Frame length byte is not included in the Frame Length calculation.

4.3. FRAME ID: Identifies the frame as a Command Frame (08h) or an ACK/NACK Frame (88h).



4.4. COMMAND ID: The following shows the composition of the Command ID part of the Command Frame.



5. COMMAND SEQUENCE

WARNING: Failure to follow the command sequence may result in corrupted camera program data. Depending on where the camera program data has been corrupted, it may be possible to restore normal operation by recycling camera power. If recycling camera power does not restore normal operation it will be necessary to return the camera to the factory for reprogramming.

5.1. The frame transfer between Host and the 3810 series camera is carried out half-duplex using the following sequence.

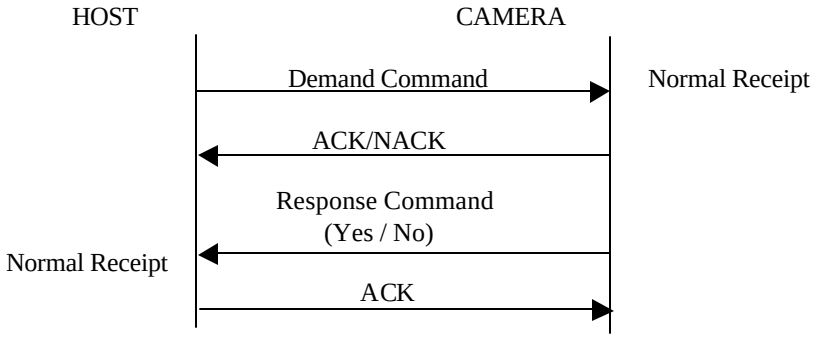
5.1.1. A Demand Command is sent from the Host to the 3810 series camera.

5.1.2. The camera returns an ACK if the Demand Command is received successfully, or a NACK if it is not received successfully. After receiving an ACK/NACK from the camera, the Host must wait until the camera has sent a Response Command, and then the Host must send an ACK to the camera. If a NACK is received, the Host must still follow this sequence, but should resend the original Demand Command after sending the ACK to the camera.

5.1.3. If the camera was successfully able to act upon the demand command, it will return a "YES" Response Command to the Host. If it was not successful the camera will return a "NO" response. If a "NO" response is received, the Host must still send a ACK to the camera and then resend the original Demand Command.

5.1.4. After receiving the response command from the camera, the Host must send an ACK to the camera. This ACK must be sent before the next demand command is sent.

5.2.



5.3. RESPONSE COMMAND

5.3.1. Refer to the Command ID, section 4.4. The Response Command is the reply from the camera to the demands from the Host. There are two types of response commands, YES and NO. When the operation defined by the demand command is completed without fail, the camera will send "YES" to the Host. If the operation is not completed "NO" will be sent from the camera to the Host. A "NO" response will be accompanied by an error classification of 11h to identify the error as an undefined command.

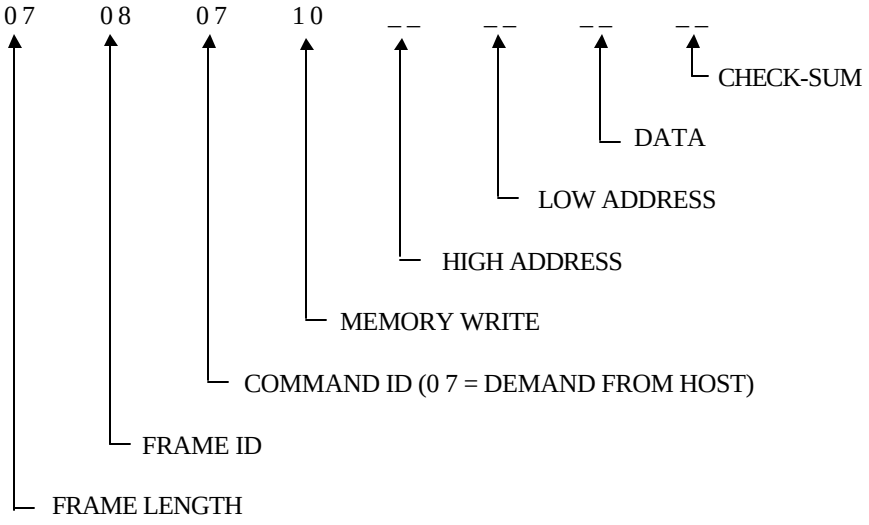
6. BYTE FORMAT

(MSB) (LSB)

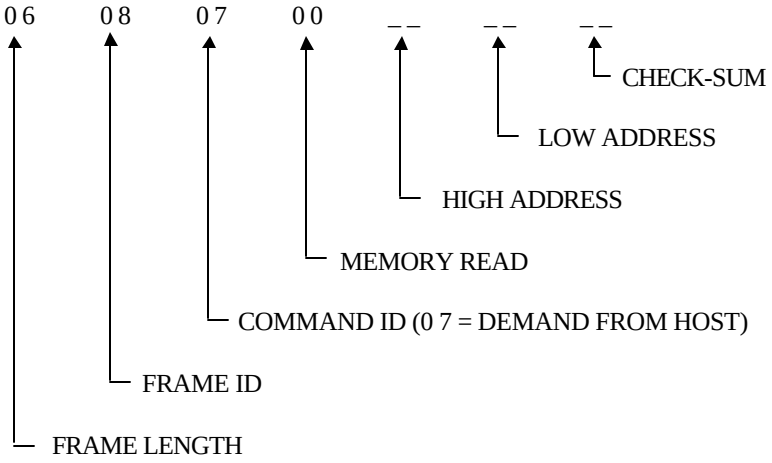
bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7

7. COMMAND FORMAT STRUCTURE

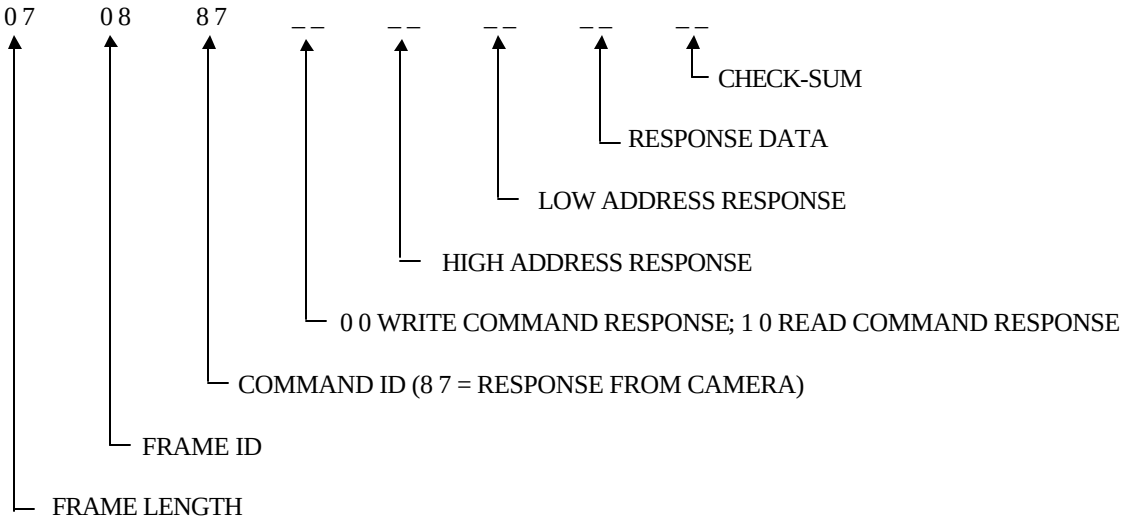
7.1. MEMORY WRITE COMMAND STRING FORMAT (Host to Camera)



7.2. MEMORY READ COMMAND STRING FORMAT (Host to Camera)



7.3. CAMERA RESPONSE COMMAND STRING FORMAT (Camera to Host)



8. INITIAL SET UP

8.1. Shown for reference only. The initial set up is performed by the factory prior to shipment of the camera. No user action is required.

WARNING: The Initial Set Up command allows permanent changes to be made to the camera program data. Improper commands or improper command protocol while the camera program data is open can result in a dysfunctional camera. This may require that the camera be returned to the factory for a complete reprogramming.

8.2. Open Camera Program Data by writing "1" into bit0 and bit7 (81) at address 19 96

8.3. SET RS232C Control by writing "1" into bit0 (80) at address 11 E8.

8.4. Close Camera Program Data by writing "1" into bit0 and "0" into bit7 (80) at address 19 96.

8.5. Command String Example:

COMMAND								DESCRIPTION
07	08	07	10	19	96	81	AA	Open Camera Program Data
07	08	07	10	11	E8	80	61	Establish RS232C Control
07	08	07	10	19	96	80	AB	Close Camera Program Data

NOTE: Refer to the BYTE Format (Section 6.0) for bit identification for the remainder of the protocol description.

9. ZOOM / MANUAL FOCUS CONTROL (ADDRESS 19 18)

9.1. Zoom Speed can be set to seven different values by writing the proper data to bit5 through bit7 (001 – 111).

9.2. The Camera must be set to the Manual Focus Mode prior to changing the manual focus

9.3. Zoom Speed and direction is accomplished via a single command. Focus speed and direction require individual commands.

9.4. Only one function can be performed at a time. It is not possible to zoom and focus at the same time.

9.5. To stop the zoom or focus command write 00 to address 19 18

9.6. Bit Identification (Address 19 18)

bit	Function	Description	Data to Write to 19 18
0	N/A	Fixed at 0	-
1	Focus FAR	Focus toward Far Speed Determined at Address 19 19	40
2	Focus NEAR	Focus toward Near Speed Determined at Address 19 19	20
3	Zoom WIDE (SLOW)	Zoom to Wide (Slow) Speed Determined by bit5 – bit7	11
3	Zoom WIDE (MED)	Zoom to Wide (Med.) Speed Determined by bit5 – bit7	14
3	Zoom WIDE (FAST)	Zoom to Wide (Fast) Speed Determined by bit5 – bit7	17
4	Zoom TELE (SLOW)	Zoom to Tele (Slow) Speed Determined by bit5 – bit7	09
4	Zoom TELE (MED)	Zoom to Tele (Med.) Speed Determined by bit5 – bit7	0C
4	Zoom TELE (FAST)	Zoom to Tele (Fast) Speed Determined by bit5 – bit7	0F
5	Zoom Speed 2	Zoom Speed 2	-
6	Zoom Speed 1	Zoom Speed 1	-
7	Zoom Speed 0	Zoom Speed 0	-

10. MANUAL FOCUS SPEED CONTROL

10.1. The Focus Speed can be set to three different values by writing the proper data to bit6 and bit 7 at address 19 19.

10.1.1. Slow – bit6 = 0; bit7 = 0
10.1.2. Med. – bit6 = 0; bit7 = 1
10.1.3. Fast – bit6 = 1; bit 7= 0

10.2. The desired focus speed must be established prior to sending the focus direction command.

10.3. It is only necessary to send the focus speed command when changing the speed.

10.4. Manual Focus Speed Data

bit	Function	Description	Data to Write to 19 19
0 – 5	N/A	Fixed at 0	000000
6	Focus SPEED 1	Focus SPEED 1	-
7	Focus SPEED 2	Focus SPEED 2	-
-	-	Focus SLOW	00
-	-	Focus MED	01
-	-	Focus FAST	02

11. ZOOM POSITION DETECT

11.1. If desired, it is possible to determine the zoom position in terms of zoom ratio by reading the data at address 1D 8A.

Data at 1D 8A	80	7A	74	6E	68	62	5C	55	4F	49	43
Optical Zoom Ratio	22x	21x	20x	19x	18x	17x	16x	15x	14x	13x	12x
Data at 1D 8A	3D	37	31	2B	25	1F	18	12	0C	06	00
Optical Zoom Ratio	11x	10x	9x	8x	7x	6x	5x	4x	3x	2x	1x

12. DIGITAL ZOOM RANGE CONTROL AND DETECT

12.1. The digital zoom range defines the amount of digital magnification that will be utilized.

12.2. After setting the digital zoom range and closing the camera program data, the new digital zoom range will become effective when the camera receives the next Zoom Tele command.

12.3. Write the appropriate data to address 15 DD to set the digital zoom range, read the data at address 15 DD to detect the digital zoom range. Setting the digital zoom range requires re-writing that portion of the camera program data. Therefore, it requires three commands to set the digital zoom range.

ZOOM RANGE	DATA at ADDRESS 15 DD
1X (Off)	00
2X	80
4X	C0
8X	E0

12.4. Command Example: Set Digital Zoom Range to 2X

COMMAND								DESCRIPTION
07	08	07	10	19	96	81	AA	Open Camera Program Data
07	08	07	10	15	DD	80	68	Set Digital Zoom Range to 2X
07	08	07	10	19	96	80	AB	Close Camera Program Data

13. AUTO FOCUS ON/OFF AND BACK LIGHT COMPENSATION ON/OFF

13.1. The Auto Focus ON/OFF and the Back Light Compensation functions share the same address (19 4C) and utilize a combined instruction set. Prior to changing one function it is necessary to first establish the current mode of the other function by reading the data at address 19 4C, and then sending the appropriate command.

NOTE: The Host control may already be aware of the current mode of the A/M Focus and the BLC, but it is recommended that the camera parameters be established by reading the data at address 19 4C, rather than rely on the host.

13.2. BYTE FORMAT for Address 19 4C

13.2.1. Bit1, Bit2, and Bit4 through Bit7 are fixed at 0
13.2.2. Bit0: “0” for Auto Focus; “1” for Manual Focus
13.2.3. Bit3: “0” for BLC OFF, “1” for BLC ON

13.3. The following table shows the data to write into address 19 4C to accomplish the desired function:

FOCUS	BLC	COMMAND	DATA AT 19 4C
MANUAL	OFF	07 08 07 10 19 4C 80 65	“1” to bit0; “0” to bit3
MANUAL	ON	07 08 07 10 19 4C 90 55	“1” to bit0; “1” to bit3
AUTO	OFF	07 08 07 10 19 4C 00 E5	“0” to bit0; “0” to bit3
AUTO	ON	07 08 07 10 19 4C 10 D5	“0” to bit0; “1” to bit3

13.4. COMMAND EXAMPLE:

13.4.1. To select Auto Focus; assumes camera is already in Manual Focus, Status of BLC must be determined.
13.4.1.1. Read status (Command 06 08 07 00 19 4C 86)
13.4.1.2. If “80” is returned, BLC is OFF, send 07 08 07 10 19 4C 00 75
13.4.1.3. If “90” is returned, BLC is ON, send 07 08 07 10 19 4C 10 65

14. WHITE BALANCE CONTROL AND DETECT

14.1. The White Balance Setting can be set by writing the following data to address 19 92, or be detected by reading the data at address 19 92.

14.2.

DATA at 19 92	WHITE BALANCE SETTING
00	AUTO
01	SET
02	LOCK
03	INDOOR
04	OUTDOOR
05	FLUORESCENT

14.3. The current camera programming has anomalies in the AUTO and the SET modes that require these commands to utilize the following command procedures:

14.3.1. To Select AUTO WHITE BALANCE
14.3.1.1. send 07 08 07 10 19 92 00 2F (Auto)
14.3.1.2. send 07 08 07 10 19 92 01 2E (Set)
14.3.1.3. send 07 08 07 10 19 92 00 2F (Auto)

14.4. To Select SET
14.4.1. send 07 08 07 10 19 92 00 2F (Auto)
14.4.2. send 07 08 07 10 19 92 01 2E (Set)

15. WHITE BALANCE MODE DETECT

15.1. The datum at address 18 7B can be read to determine whether the White Balance Command was successful, or if the White Balance function is still busy.

15.2. After a successful white balance action bit0 through bit3 will be 0111 or greater, and bit4 and bit5 will equal “0”. Any other data returned from the camera indicates that the white balance operation was not successful.

15.3. bit5 = 1 indicates that the white balance action is still being performed (i.e.: busy)

16. SHUTTER SPEED CONTROL AND DETECT

NOTE: Due to anomalies within the current camera program, to maintain correct iris operation, it is necessary to step through Auto Shutter mode when changing from less than 1/60 second (1/50 second for PAL) to longer than 1/60 (1/50 second for PAL).

NOTE: The Auto Shutter function works in conjunction with the Auto Iris function. As such, selecting Auto Shutter, or stepping through the Auto Shutter function, forces the camera into the Auto Iris mode. The control Host must be updated accordingly.

REFERENCE: Operational Description - When operating in the Auto Shutter / Auto Iris mode, the Auto Iris responds to increases in scene illumination by closing down. In addition to closing down, a 0.8 Neutral Density Filter is attached to an iris leaf so that as the aperture closes the N.D. is slowly inserted into over the aperture. At f/5.6 the N.D. fully covers the entire aperture. As the scene illumination continues to increase, the iris continues to close until it reaches f/22. At this point the iris stops moving, and the shutter speed begins to decrease until it reaches 1/250 second. If the scene illumination continues to increase beyond this level, the Auto Iris will begin to close again to f/32. This setting will provide sufficient attenuation to allow the camera to be used in the brightest possible daylight conditions of 100,000 Lux.

16.1. The shutter speed can be selected by writing the appropriate data to address 19 95.

16.2. The shutter speed can be detected by reading the datum at address 19 95.

16.3.

SHUTTER SPEED	DATA at 19 95
1/10,000 Second	08
1/4,000 Second	07
1/2,000 Second	06
1/1,000 Second	05
1/500 Second	04
1/250 Second	03
1/100 (1/120 PAL) Second	02
1/60 (1/50 PAL) Second	01
AUTO	00
1/30 Second	FF
1/15 Second	FE
1/8 Second	FD
1/4 Second	FC

17. IRIS POSITION DETECT

17.1. The position of the iris can be detected by reading the datum at address 1B 07 and 1B 08. This datum can be compared to a look up table to determine the current f/number of the aperture.

17.2. The iris position can only be read. It is not possible to write the iris position.

17.3. Iris position data table

DATA at 1B 07	DATA at 1B 08	IRIS STATUS (f/Num)
02	66	FULLY OPEN (f/1.6)
01	F5	f/2.0
01	9B	f/2.8
01	62	f/4.0
01	41	f/5.6
01	27	f/8.0
01	10	f/11.0
01	02	f/16.0
00	F3	f/22.0
00	EB	f/32.0
00	CD	FULLY CLOSED

18. AUTO/MANUAL IRIS and AUTO/FIXED GAIN CONTROL

NOTE: Auto Shutter has priority over Manual Iris. If camera is in Auto Shutter do not allow Manual Iris to be selected. Refer to the Auto Shutter section 16.0 for additional information regarding the relationship between Auto Shutter and Auto Iris.

NOTE: Selecting Manual Iris forces the camera into a Fixed Gain Mode. The Gain will remain at the same value it was at when manual iris was selected.

18.1. Auto/Manual Iris selection is a Toggle function utilizing the same command to toggle between Auto and Manual iris. The current mode of the A/M iris should first be determined before sending the toggle command.

18.2. The current mode of the A/M iris function can be determined by reading the data at address 19 94.

18.2.1. If the datum returned is “00” the camera is in the Auto Iris Mode. Any other value indicates the camera is in the Manual iris mode.

18.3. To toggle the A/M Iris state, write “20” to address 19 94

18.3.1. Command example: 07 08 07 10 19 94 20 0D

19. MANUAL IRIS CONTROL:

NOTE: If camera is in Auto Iris mode, do not allow manual iris controls to be sent.

19.1. ADJUSTMENT RANGE and POSITION DETECT

19.1.1. The Manual Iris range is limited by the scene conditions present at the time the manual mode is selected.

19.1.2. The iris is moved in steps, one step for each command received. There is a maximum of 11 toward open and 11 steps toward close. 11 steps are approximately equivalent to a 3dB change in the video output level.

19.1.3. The current position of the manual iris can be determined by reading the datum at address 1B 1F.

19.1.4. Refer to the following table to determine the current position and the number of adjustment steps available. The "0" step is the position the iris is in when the manual mode is first selected.

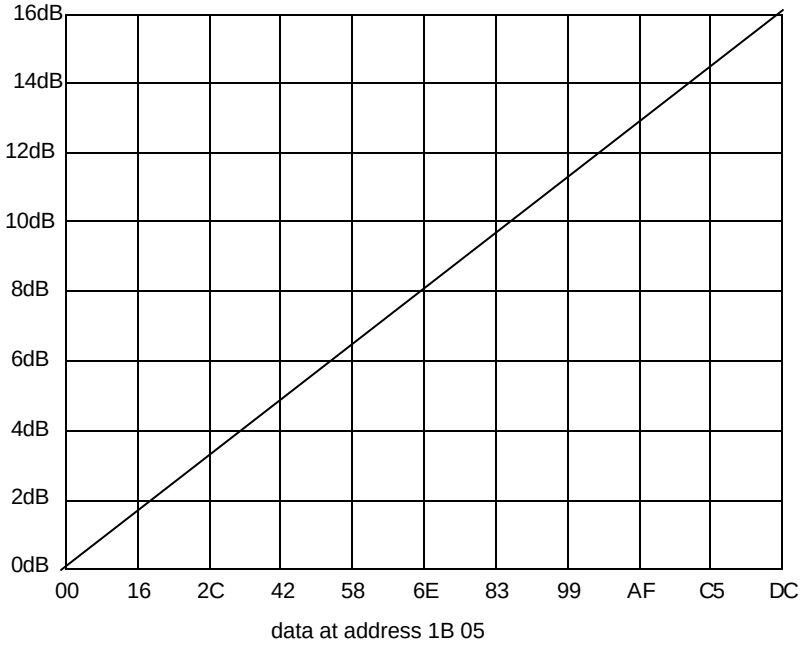
-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	← STEPS
0C	0D	0E	0F	10	11	12	13	14	15	16	17												11 Steps Close
0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17											11 Steps Close, 1 Step Open
0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17										11 Steps Close, 2 Steps Open
09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17									11 Steps Close, 3 Steps Open
08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17								11 Steps Close, 4 Steps Open
07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17							11 Steps Close, 5 Steps Open
06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17						11 Steps Close, 6 Steps Open
05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17					11 Steps Close, 7 Steps Open
04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17				11 Steps Close, 8 Steps Open
03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17			11 Steps Close, 9 Steps Open
02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17		11 Steps Close, 10 Steps Open
01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	11 Steps Close, 11 Steps Open
	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	10 Steps Close, 11 Steps Open
		01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	9 Steps Close, 11 Steps Open
			01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	8 Steps Close, 11 Steps Open
				01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	7 Steps Close, 11 StepsOpen
					01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	6 Steps Close, 11 Steps Open
						01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	5 Steps Close, 11 Steps Open
							01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	4 Steps Close, 11 Steps Open
								01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	3 Steps Close, 11 Steps Open
									01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	2 Steps Close, 11 Steps Open
										01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	1 Step Close, 11 Steps Open
											01	02	03	04	05	06	07	08	09	0A	0B	0C	11 Steps Open

19.2. To OPEN the iris ONE STEP, write "08" to address 19 94
19.3. To CLOSE the iris ONE STEP, write "04" to address 19 94)

20. GAIN STATUS DETECT

20.1. The Gain value can be detected by reading the data at address 1B 05. The following table shows the relationship between the datum and the corresponding amount of camera gain.

20.2. The camera gain can only be READ. It is not possible to WRITE the camera gain.



21. PRESETS

21.1. There are 64 possible Zoom and Focus presets positions.

21.2. Storing a preset position stores both zoom and focus positions. Recalling a preset position recalls both zoom and focus positions.

21.3. Recalling a preset position forces the camera into the Manual focus mode. The control host should be updated accordingly. If Auto focus is required after recalling a preset position it will be necessary to send an auto focus command.

21.4. Presets are controlled by the data at address 19 DB according to the following table:

bit	Description
0	1 = Recall Position
1	1 = Store Position
2 through 7	64 Preset Positions

21.5. Command Examples:
21.5.1. 07 08 07 10 19 DB 80 66 = Store Preset position 0 (Data bits: 1 0 0 0 / 0 0 0 0 = 80)
21.5.2. 07 08 07 10 19 DB BF 27 = Store Preset position 63 (Data bits: 1 0 1 1 / 1 1 1 1 = BF)
21.5.3. 07 08 07 10 19 DB 40 A6 = Recall Preset position 0 (Data bits: 0 1 0 0 / 0 0 0 0 = 40)
21.5.4. 07 08 07 10 19 DB 7F 67 = Recall Preset position 63 (Data bits: 0 1 1 1 / 1 1 1 1 = 7F)

22. BACK UP FUNCTION CONTROL

22.1. A Back up function provides the ability to store and recall the following parameters:

22.1.1. Zoom Position
22.1.2. Focus Position
22.1.3. Focus Mode (Auto or Manual)
22.1.4. Shutter Speed (within 1/1,000 second through ¼ second range)
22.1.5. White Balance Mode (Auto, Set, Lock, Indoor, Outdoor, or Fluorescent)

22.2. The back up feature does not include Auto / Manual Iris. The camera will always start in the Auto Iris mode.

22.3. To Store the back up data write “BF” to address 19 DB

22.4. To Recall the back-up data write “7F” to address 19 DB

23. CHECK ZOOM

23.1. The camera may experience a gross loss of focus as the lens is zoomed. This typically occurs as a result of a severe shock or when the camera program data has been corrupted through improper communications. If this should occur it may be possible to restore correct operation by performing a Check Zoom operation.

23.2. Position the camera to view the attached pattern at a distance of 7.9 feet. The pattern should be centered in the image.

23.3. Send the Check Zoom command 07 08 07 10 1E 0E 10 9E

23.4. The camera will automatically zoom and focus for 1 to 3 minutes.

23.5. It may be necessary to turn camera power off and on, and then repeat the CZ command.

23.6. CZ Pattern