



Tamarisk[®] 640

17 μ m 640x480 Long Wave Infrared Camera
Software Interface Control Document

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DRS Technologies

A Finmeccanica Company

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Rev History

Revision Number	Release Date	Description
A	01/26/2013	Initial Draft
B	05/31/2013	Update for V1.2 features.
C	11/15/2013	Updated ICE Commands and Prepared for Public Release

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Description	Abbreviation	Description
°C	Celsius	mm	millimeter
°F	Fahrenheit	ms	milliseconds
AGC	automatic gain control	MSB	Most Significant Bit
BPR	bad pixel replacement	MTU	Maximum Transfer Unit
CCA	circuit card assembly	MWIR	Mid-wave infrared
CL	center line	NETD	noise equivalent temperature difference
COMM	communication	NTSC	National Television System Committee
CSC	Computer Software Component	NUC	non-uniformity correction
CSCI	Computer Software Configuration Item	NVTHERM	Night Vision Thermal Analysis Tool
CSU	Computer Software Unit	OEM	original equipment manufacturer
dB	decibels	OLA	Optical Lens Adapter
DSP	digital signal processor	P	probability
ESD	electrostatic discharge	POL	polarity
E-Zoom	electronic zoom	psi	pound per square inch
FOV	field of view	Rev	revision
FPA	Focal Plane Array	ROI	region of interest
ft	feet	SC	split configuration
G	gravitational force	SWIR	Short-wave infrared
g	gram	TBD	To Be Determined
GUI	graphical user interface	TCR	Temperature coefficient of resistance
H	height	TIM	Thermal Imaging Module
HFOV	horizontal field of view	UART	Universal Asynchronous Receiver Transmitter
I/O	input/output	UAV	unmanned aerial vehicle
ICD	Interface Control Document	UFPA	Un-cooled Focal Plane Array
ICE	Image Contrast Enhancement	USB	Universal Serial Bus
ID	identification	V	Vertical or Voltage
IR	infrared	VDC	volts direct current
IRS	Interface Requirements Specification	VGA	video graphics array
km	kilometer	VOx	Vanadium Oxide
LR	lower right	W	width or Watt
LWIR	long-wave infrared	μm	micron (micrometer)

REFERENCE DOCUMENTATION

The following documents form part of this specification. In the event of a conflict between documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

Document No: 1014853 Tamarisk[®]₆₄₀ User Manual

Document No: 1014845 Tamarisk[®]₆₄₀ Electrical Interface Control Document

Document No: 1014846 Tamarisk[®]₆₄₀ Camera Control Software User Guide

Document No: 1010056 Tamarisk[®]₆₄₀ Mechanical Interface Control Document

SAFETY INSTRUCTIONS

NOTIFICATIONS: CAUTION, WARNING AND NOTE

Throughout this manual, notifications are used to alert the user's to potential risks and to minimize the potential for personal injury and or damage to the product. When a notification is present, it is important that the user review and understand all statements related to the notification before proceeding. If questions arise, please contact your authorized dealer or DRS Technologies.

Notifications are preceded by a symbol and followed by highlighted text. Three types of notifications are used throughout this manual and are defined below:



CAUTION

A caution is a procedure, practice, or condition that, if not strictly followed, may result in personal injury or damage to the equipment that may impede product performance.



WARNING

A warning is intended to alert the user to the presence of potentially harmful circumstances and provide precautionary guidance for mitigating risk of personal injury and or damage to the product.



NOTE

A note is a statement that clarifies or is used to emphasize important information.

1. Read all instructions
2. Keep these instructions for future reference.
3. Follow all instructions
4. Heed all warnings.
5. Do not submerge this apparatus in liquid of any kind.
6. Clean per recommended instructions using dry non-abrasive cloth.
7. Do not install near any sources of intense heat such as radiators, furnaces, stoves or other apparatus that regularly produce excessive heat.
8. Refer all servicing to qualified service personnel

1 SCOPE

This document describes the serial protocols and command interface for systems employing the Tamarisk[®]₆₄₀ Software Architecture. The Tamarisk[®]₆₄₀ Software Architecture is a design for an infrared thermal imaging core that uses an un-cooled focal plane array (UFPA).

1.1 SYSTEMS OVERVIEW

A thermal imaging module (TIM) based on the Tamarisk[®]₆₄₀ Software Architecture communicates with a connected device via the serial protocol described herein. The connected device is often a personal computer (PC) running a graphical user interface (GUI) but may be a controller in an embedded system. The connected device uses the serial protocol to configure, control, and monitor status of the thermal imaging module.

Additionally, specific features of the system are tested by the serial protocol. This feature is useful for troubleshooting anomalous TIMs.

1.2 DOCUMENT OVERVIEW

This document describes the commands, parameters, and responses of the Tamarisk[®]₆₄₀ Software Architecture. The Tamarisk[®]₆₄₀ Software Architecture is not a product in and of itself; it is a component in a system. This document describe the commands for this specific component. Other individual systems based on the Tamarisk[®]₆₄₀ Software Architecture may include additional commands that are specific to that system.

This document does not describe the physical interface to the system. The physical interface will vary for each system. Typically, the serial protocol is transported over RS-232 links but USB and LVCMOS UART interfaces are supported. The Tamarisk[®]₆₄₀ Electrical Interface Control Document describes the connectors, voltage levels, framing, and data rates on which this protocol resides. See Reference Documents for details.

2 MESSAGE FORMAT - GENERAL

The serial protocol allows the user to control and monitor status of the thermal imaging module.

Every message transmitted or received over the serial interface uses the same message format. The message contains the following components:

1. **Start Character** – this is always 0x01. It identifies the start of a new message. Note that the start character is not guaranteed to be unique in the serial data stream. Other fields within the message may also contain this value.
2. **Command Byte** – This byte determines the type of command to be performed. For responses, this byte identifies the type of response.
3. **Parameter Length** – this byte specifies the count of any additional parameter bytes included in the message. If the message does not require any additional parameter bytes this value will be zero. Note that the overall message length is limited by the MTU size (see below).
4. **Parameters** – These bytes contain any parameters, or other data for the message. Generally, the content and format of this data will depend on the specific message type. However, a few general rules apply:
 - ◆ When parameter bytes contain strings, these are typically null-terminated arrays of ASCII codes.
 - ◆ When data bytes contain integer or floating-point values, these are sent in big-endian order – e.g., the MSB is sent first. This statement is true for both 16 and 32-bit values.
5. **Checksum** – This is the frame check sequence for the message. It includes all bytes in the message from the start character to the last parameter byte. It is calculated with the formula in paragraph 2.1.

The Maximum Transfer Unit (MTU) size of the serial stream is 252 bytes. .

The parameter length for most messages is an even number of bytes (there are exceptions). This is due to the 16-bit legacy architectures for which the protocol was developed.

The message format is illustrated below:

Table 1 – General Message Format

Byte	Value/Type	Description
1	0x01 (always)	Start of message.
2	Unsigned integer	Command ID.
3	0 to 252	Parameters length.
4 to (N + 3)	Message dependent	Additional Data (0 to 252 bytes).
(N + 4)	checksum	Frame check sequence. See paragraph 2.1.

2.1 CHECKSUM COMPUTATION

Every message has an appended 8-bit checksum. The checksum is computed using all bytes in the message from the start character to the last data byte.

$$Checksum = \left(\sum_{i=1}^N -byte(i) \right) \text{ modulo } 256$$

Note that summing the negative byte values must be performed using 2's-complement math, which is common on most processors. Below is example code that computes the message checksum:

```

Uint8
ComputeChecksum (Uint8      uy_message_id,
                 Uint8 *   pauly_parameters,
                 Uint32    ul_parameters_size_in_bytes)
{
    Uint8    uy_message_checksum = 0 ;

    uy_message_checksum -= 0x01 ; // start character
    uy_message_checksum -= uy_message_id ;
    uy_message_checksum -= ul_parameters_size_in_bytes ;

    while (ul_parameters_size_in_bytes --)
    {
        uy_message_checksum -= * pauly_parameters ++ ;
    }

    uy_message_checksum &= 0xFF ;

    return uy_message_checksum ;
}
// ComputeChecksum

```

Alternatively, the checksum may be computed using the equivalent formula that follows:

$$Checksum = (\sim(\text{two's complement sum of all message byte}) + 1) \& 0xFF$$

For example, let's say that the checksum for 0x01 0x2A 0x02 0x00 0x01 needs to be computed. The two's complement sum of all the message bytes would be

$$0x01 + 0x2A + 0x02 + 0x00 + 0x01 = 0x2E$$

Next, the formula indicates that the 0x2E must be inverted.

$$\sim 0x2E = 0xFFF...FFFD1$$

Then, 1 must be added.

$$0xFFF...FFFD1 + 1 = 0xFFF...FFFD2$$

Finally, a bit-wise AND with 0xFF needs to be performed.

$$0xFFFF...FFFD2 \& 0xFF = 0xD2.$$

Note that the bit-wise AND operation ensures the checksum length remains 1 byte.

2.2 COMMAND MESSAGE FORMAT

All commands originate from the connected device and are sent to the thermal imaging module (TIM). The TIM does not originate commands but it may send occasional text messages.

All commands conform to the general message format. The command byte identifies the specific command to be performed. Additional data bytes are included in the command as required. Refer to command details section for specifics.

The module will be ready to accept commands within 2 seconds of power-on.

2.3 RESPONSE MESSAGE FORMAT

All commands sent to the TIM are expected to receive at least one response message (exception: changing the baudrate command will not produce a response).

In general, systems communicating with the TIM should wait for the response message prior to subsequent messages being sent.

If the TIM finds a message format error or bad checksum, the TIM will not send a response.

If the message format and checksum is correct, but the command is not recognized, the TIM will send an Error (ERR) response. The error response may include a descriptive string that describes the error.

If the received message is properly formatted (including checksum) and the command is recognized, the TIM will generate an Acknowledgement (ACK) response.

On select commands, the module may send other responses. The type of response depends on the command that was received. Response types are:

- ◆ A text message. These are output using the TXT identifier. The text message will contain the requested information or other feedback (see the individual message detail) as null-terminated ASCII strings.
- ◆ A value message. These are output using the VALUE identifier. The value message includes a 16-bit numerical value.
- ◆ The original command. The command will contain new parameters that include the response data.

Table 2 – Response Message Types

Name	Command ID	Additional data
Text message (TXT)	0x00	Text message (variable # of bytes defined in the Data Length field)

		Note: to receive a text message, the module must have debug message mode ON.
Acknowledgement (ACK)	0x02	Data filed includes 16-bit command ID of the serial command that is being acknowledged
Not acknowledged (NAK)	0x03	Data filed includes 16-bit command ID of the serial command that is being unacknowledged
Error (ERR)	0x04	Data filed include 16-bit command ID of the serial command that is in error
16-bit integer return value (VALUE)	0x45	16-bit integer value broken up into 2 bytes
CMD	Cmd	Returns command code with response data

2.3.1 TXT Response

The TXT (Text) response provides feedback in human-readable form. The TXT message contains an ASCII string of arbitrary length (the entire message must be less than the MTU size). The connected unit may display the ASCII text as it sees fit or may discard the information.

Table 3–TXT Response Format

Byte	Value/Type	Description
1	0x01	Start of message.
2	0x00	TXT Response ID.
3	N	Number of text bytes to follow.
4 to (N+3)	ASCII chars	ASCII text. Null termination not required.
(N+4)	checksum	Frame check sequence. See paragraph 2.1.

Table 4 –Example TXT Response

Byte	Value/Type	Description
1	0x01	Start of message.
2	0x00	TXT Response ID.
3	0x06	Text message contains 6 characters.
4 to 9	0x48 ("H") 0x6F ("o") 0x77 ("w") 0x64 ("d") 0x79 ("y") 0x21 ("!")	ASCII text ("Howdy!")
10	checksum	Frame check sequence. See paragraph 2.1.

2.3.2 ACK Response

The ACK response is a general-purpose acknowledgement that a command has been received. Some commands will result in two ACK messages – one generated upon receipt of the command and a second generated upon completion of the command. The ACK message contains the ID of the command being acknowledged.

Table 5 –ACK Response Format

Byte	Value/Type	Description
1	0x01	Start of message.
2	0x02	ACK Response ID.
3	0x02	ACK responses always have 2 parameter bytes.
4, 5	Command ID	ID of command that is being ACK'd. Command IDs are 8 bits in commands but are extended to 16 bits in an ACK.
6	checksum	Frame check sequence. See paragraph 2.1.

2.3.3 NAK Response

The NAK response is generated to indicate a command cannot be processed for some reason. The Tamarisk[®] 640 architecture currently does not use the NAK response.

Table 6– NAK Response Format

Byte	Value/Type	Description
1	0x01	Start of message.
2	0x03	NAK Response ID.
3	0x02	NAK responses always have 2 parameter bytes.
4, 5	Command ID	ID of command that is being NAK'd. Command IDs are 8 bits in commands but are extended to 16 bits in an NAK.
6	checksum	Frame check sequence. See paragraph 2.1.

2.3.4 ERR Response

The ERR response is generated when a command is not recognized or when an error occurs during the processing of a command. There are two formats for the ERR response. The first format contains only the ID of the command that generated the error. The second format contains an informative text message.

Table 7– ERR ID Response Format

Byte	Value/Type	Description
1	0x01	Start of message.
2	0x04	ERR Response ID.
3	0x02	ERR responses always have 2 parameter bytes.
4, 5	Command ID	ID of command that caused ERR. Command IDs are 8 bits in

6	checksum	commands but are extended to 16 bits in an ERR. Frame check sequence. See paragraph 2.1.
---	----------	---

Table 8– ERR String Response Format

Byte	Value/Type	Description
1	0x01	Start of message.
2	0x04	ERR Response ID.
3	N	Number of text bytes to follow.
4 to (N+3)	ASCII chars	ASCII text string that contains error message. Null termination not required.
(N+4)	checksum	Frame check sequence. See paragraph 2.1.

2.3.5 VALUE Response

The VALUE response is generated when a command returns a single 16-bit integer value.

Table 9– VALUE Response Format

Byte	Value/Type	Description
1	0x01	Start of message.
2	0x45	VALUE Response ID.
3	0x02	VALUE responses always have 2 parameter bytes.
4, 5	Unsigned integer	Value.
6	checksum	Frame check sequence. See paragraph 2.1.

2.3.6 CMD Response

The command response is generated by any command that requires a response that does not fit any of the prior response types. The content of the response is dependent on the command and the nature of the response.

Table 10 – CMD Response Format

Byte	Value/Type	Description
1	0x01	Start of message.
2	Command ID	ID of corresponding command.
3	N	Number of bytes to follow.
4 to (N+3)	varies	The contents of this field depend on the command and response type.
(N+4)	Checksum	Frame check sequence. See paragraph 2.1.

2.4 RESPONSE MESSAGE TIMING

An ACK response will nominally be returned within 1 second of the command being sent. However, there are exceptions:

1. If the command causes flash memory to be erased or programmed, the command can take somewhat longer before generating an ACK. The time is dependent on a number of factors:
 - ◆ The number of flash sectors being erased or programmed. More sectors will require more time.
 - ◆ The temperature of the flash. Colder flash parts require more time to erase and program.
2. The response time for non-ACK response (ERR, NAK, etc) types depends on the type of command.

2.5 COMMAND/RESPONSE SEQUENCE

Generally, every command is followed by an ACK response. However, there are numerous exceptions:

1. Some commands will return a VALUE response or a response having the same message ID as the command followed by an ACK.
2. Data transfer activities have a unique message sequence that is dependent on whether an upload or download is requested, the size of the transfer, and any errors that may occur during transfer.

2.6 CAMERA MEMORY DATA DOWNLOAD

Information in non-volatile memory may contain some information that is useful in system development. Table 18

shows the data available in non-volatile storage. A sequence of commands is required to download this information, and the information will need to be parsed according to the table. Figure 1 shows the command sequence between the connected unit (CU) and the thermal imaging module (TIM).

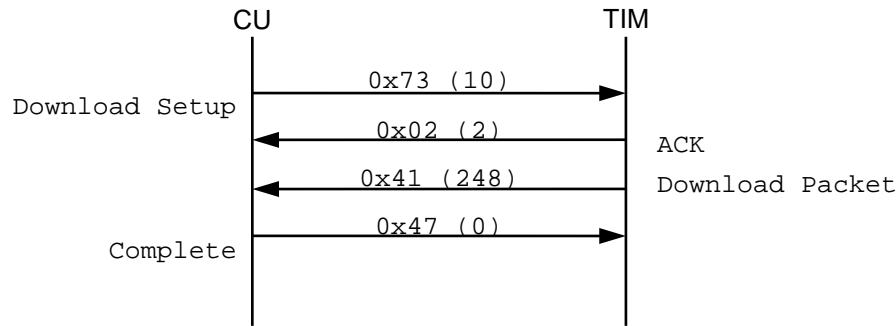


Figure 1 - Download command sequence

2.6.1 Download from Thermal Imaging Module (TIM) to Connected Unit (CU)

A download from the TIM is initiated by the CU with the “Data Transfer Download Setup” message (0x73). This message has five, 16-bit parameters (10 bytes total). The parameters identify the device; region, range, and size of the download (see Figure 1)

The TIM checks the size and region parameters and, if acceptable, responds with an ACK (0x02).

The TIM then begins sending packets to the CU using “Data Transfer Download Packet” messages (0x41). Each packet message carries a payload whose size is always an even number of bytes. The payload packet contains a packet number (16-bits) and packet payload bytes. Payload size has historically been 244 bytes. The packet number is a zero-based, integer count packets. It is used to detect missing packets and to initiate retries. The TIM continues to transmit packets until the entire object is transmitted.

At any time during the transmission, the CU may send a “Data Transfer Upload Retry” message (0x46) to indicate an error. The retry contains one 16-bit parameter that is the packet number of the last packet received in order. Upon receipt of this message, the TIM will retransmit all packets following the packet number.

At any time, the CU may send a “Data Transfer Abort” message (0x43). Upon receipt of this message, the TIM will terminate transmission of packets, reset its internal state machines, and await a new setup message.

Following receipt of the last data packet, the CU will send a “Data Transfer Download Complete” message (0x47). This message indicates that the entire object has been received intact by the CU and that data transfer operations will cease.

2.6.1.1 Data Transfer Download Setup – 0x73

Description: Setup a download from the TIM to the connected unit.

Command Format:

Table 11 – Data Transfer Download Setup Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x73	Data Transfer Download Setup Command ID.
3	0x0A	Parameters length.
4 to 7	unsigned integer	Transfer size in bytes.
8, 9	unsigned integer	0x0001
10, 11	unsigned integer	0x001A
12, 13	unsigned integer	0x0000.
14	checksum	Frame check sequence.

Response Format:

Table 12 – Data Transfer Download Setup Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response.
3	0x02	Parameters length.
4, 5	0x0073	Data Transfer Download Setup Command ID.
6	checksum	Frame check sequence.

2.6.1.2 Data Transfer Download Packet – 0x41

Description: Carries payload bytes for the data transfer download.

Command Format:

Table 13 – Data Transfer Download Packet Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x41	Data Transfer Download Packet Command ID.
3	N	Parameters length.
4, 5	unsigned integer	Packet number. The first packet is 0.
6 to (N+3)	(any)	Packet payload. The number of bytes in this array varies. These are a portion of the bytes of the payload object being sent from the TIM.
(N+4)	checksum	Frame check sequence.

Response Format:

There is no response to this command unless packet is corrupted or is the last packet of the transfer.

- If this packet is corrupted, the CU should generate a “Data Transfer Download Retry” message (0x46) containing the packet number of the expected packet.
- If this packet is the last packet of the transfer, the CU should generate a “Data Transfer Download Complete” message (0x47) that contains success status.

2.6.1.3 Data Transfer Download Retry – 0x46

Description: Setup a download from the TIM to the connected unit.

Command Format:

Table 14 – Data Transfer Download Retry Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x46	Data Transfer Download Packet Command ID.
3	0x02	Parameters length.
4, 5	unsigned integer	Packet number of expected packet.
6	checksum	Frame check sequence.

Response Format:

There is no response to this command other than to resume packet transmission at the packet number of the expected packet. All packets following the expected packet shall be retransmitted.

2.6.1.4 Data Transfer Download Complete – 0x47

Description: Indicates the CU has received all packets of the download and data transfer operations will cease.

Command Format:

Table 15 – Data Transfer Download Complete Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x47	Data Transfer Download Complete Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

There is no response to this command. Upon receipt of this command, the TIM will cease data transfer operations.

2.6.1.5 Data Transfer Abort – 0x43

Description: Abort a data transfer. This command can be used to abort both uploads and downloads.

Command Format:

Table 16 – Data Transfer Abort Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x43	Data Transfer Abort command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 17 – Data Transfer Abort Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response
3	0x02	Parameters length.
4, 5	0x0043	Data Transfer Abort command ID.
6	checksum	Frame check sequence.

2.6.2 Non-volatile Camera System Information.

There is information contained in the non-volatile memory that some customers may desire to use for their products, such as camera part numbers and serial numbers. This information is downloadable and parsable based on the information in Table 18. The Data Transfer Download Setup Command (0x73) is used to download this information. To download the data shown in Table 18 the user would write the following serial command to the camera:

0x01 0x73 0x0a 0x00 0x00 0x00 0x01 0x00 0x01 0x00 0x1a 0x00 0x00 0x66

Table 18 – TIM Manufacturing Information

Item	Length (in bytes)	Conversion from raw bytes
Mfg date information	2	Year = int(data[0]) * 256 + int(data[1])
Mfg date information	1	Month = int(data[2])
Mfg date information	1	Day = int(data[3])
Mfg date information	2	Year = int(data[4]) * 256 + int(data[5])
Mfg date information	1	Month = int(data[6])

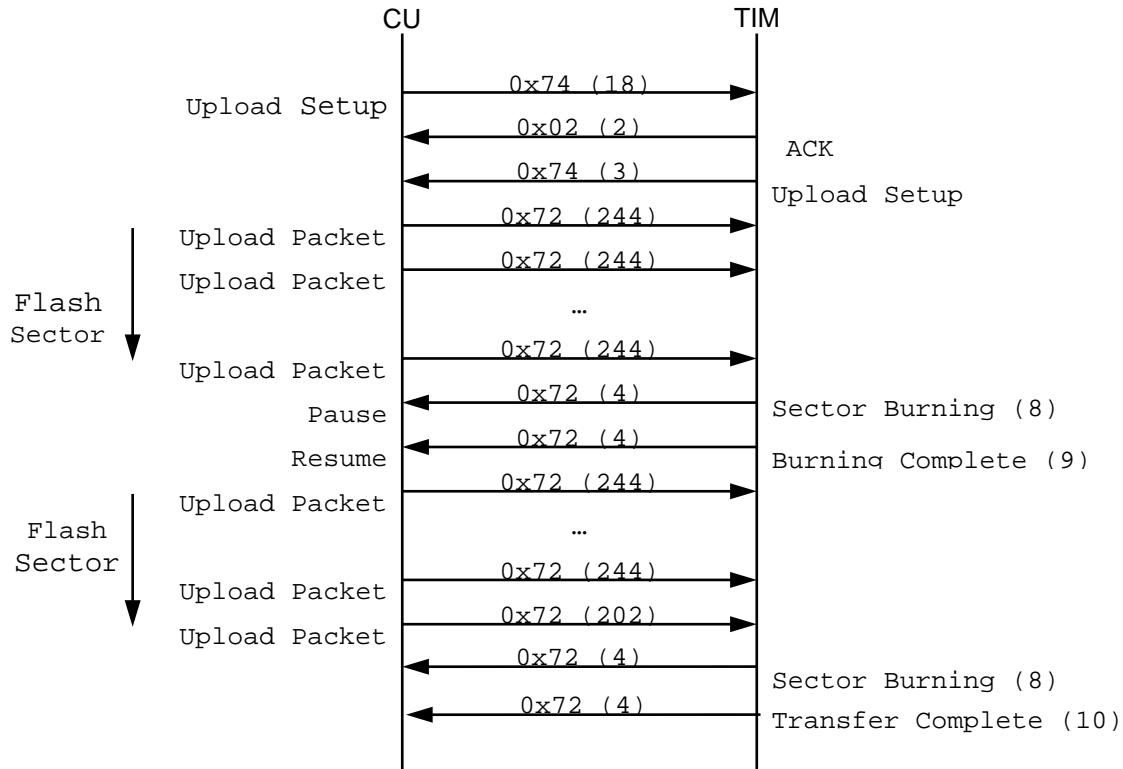
Item	Length (in bytes)	Conversion from raw bytes
Mfg date information	1	Day = int(data[7])
Mfg date information	2	Year = int(data[8]) * 256 + int(data[9])
Mfg date information	1	Month = int(data[10])
Mfg date information	1	Day = int(data[11])
Mfg calibration information	6	Chamber = string(data[12:17])
Mfg calibration information	6	Position = string(data[18:23])
Mfg calibration information	10	Version = string(data[24:33])
Mfg software information	10	Version = string(data[34:43])
Mfg software information	10	Version = string(data[44:53])
Module Part Number	20	Part Number = string(data[54:73])
Module Serial Number	20	Serial Number = string(data[74:93])
Detector Part Number	20	Part Number = string(data[94:113])
Detector Serial Number	20	Serial Number = string(data[114:133])

2.7 CAMERA DATA UPLOAD

If the Tamarisk[®]₆₄₀ camera is integrated in a system there may be occasions an embedded firmware or embedded hardware programs could require an update. Customers that desire supporting that update through their software or hardware would follow the upload procedure described below:

An upload to the TIM is initiated by the CU (connected with the “Data Transfer Upload Setup” message (0x74). This messages has 9, 16-bit parameters (18 bytes total). The parameters identify the device, region, range, size and CRC of the upload (see Figure 2).

Figure 2– Upload to TIM Message Sequence Diagram



The TIM checks the size and region parameters and, if acceptable, responds with an ACK and setup response. The setup response message has the same command ID as the setup message (0x74) and has 3, 16-bit parameters.

The CU then begins sending packets to the TIM using “Data Transfer Upload Packet” messages (0x72). Each packet message carries a payload whose size is always an even number of bytes. The payload packet contains a packet number (16-bits) and packet payload bytes. Payload size has historically been 244 bytes. The packet number is a zero-based, integer count packets. It is used to detect missing packets and to initiate retries.

At any time, the TIM may send a “Data Transfer Upload Packet” (0x72) message to the CU to control the flow of packets or to indicate an error condition. This flow control message includes 2, 16-bit parameters. The first is a response ID and the second is a packet number. When the CU receives the flow control message, it should respond as indicated in Table 24

At any time, the CU may send a “Data Transfer Abort” message (0x43). Upon receipt of this message the TIM will reset its internal state machines and await a new setup message.

Following transmission of the last data packet, the TIM will send a flow control message with ID=8 to indicate flash is being programmed followed by a flow control message with ID=10 to indicate that the upload has been successful, the flash burn is complete, data transfer operations will now cease.

2.7.1 Data Transfer Upload Setup – 0x74

This message is used as both a command to the TIM and a response to the CU.

Description: Sets up a transfer from the connected unit to the TIM.

Command Format:

Table 19 – Data Transfer Upload Setup Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x74	Data Transfer Upload Setup Command ID.
3	0x12	Parameters length.
4, 5	Unsigned integer	0x00, 0x00
6, 7	Unsigned integer	0x00, 0x01
8, 9	Unsigned integer	Software: 0x00, 0x0C FPGA:0x00, 0x0E
9, 10	Unsigned integer	0x00, 0x00
10, 11	Unsigned integer	0x00, 0x00
12, 13	Unsigned integer	0x00, 0x00
14, 17	Unsigned integer	Total size of transfer.
18, 19	Unsigned integer	CRC of entire transfer.
6	checksum	Frame check sequence.

Response Format:

Table 20 – Data Transfer Upload Setup Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x74	Data Transfer Upload Setup Command ID.
3	0x06	Parameters length.
4, 5	0x0000	Always 0.
6, 7	0x0000	Always 0.
7, 8	Unsigned Integer	Response ID. See table below.
9	checksum	Frame check sequence.

Table 21 – Data Transfer Upload Setup Response ID

Response ID	Description
1	Success, Setup accepted. Upload can proceed.
3	Error in Device ID, Region ID, or Range ID. Setup failed.

7	Illegal Size. Size of upload does not agree with expected size. Setup failed.
---	---

2.7.2 Data Transfer Upload Packet – 0x72

This message is used as both a command to the TIM and a response to the CU.

Description: Carries data to be uploaded to the TIM. The response provides flow control and error notification to CU.

Command Format:

As a command, this message carries payload data for a data transfer upload to the TIM from the CU. The message contains a 16-bit, unsigned, zero-based packet number followed by payload bytes. Following the payload bytes is a 16-bit packet CRC. The number of payload bytes will vary but the entire message must be less than the MTU size.

Table 22 – Data Transfer Upload Packet Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x72	Data Transfer Upload Setup Command ID.
3	N	Parameters length.
4, 5	Unsigned integer	Packet number. First packet is 0.
6 to (N+1)	(any)	Packet payload. The number of bytes in this array varies. These are a portion of the bytes of the payload object being sent to the TIM.
(N+2), (N+3)	Unsigned Integer	Packet CRC
(N+4)	checksum	Frame check sequence.

Response Format:

Table 23 – Data Transfer Upload Packet Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x72	Data Transfer Upload Setup Command ID.
3	0x06	Parameters length.
4, 5	unsigned integer	Response ID. See table below.
6, 7	unsigned integer	Packet number. First packet is 0.
8	checksum	Frame check sequence.

Table 24 – Data Transfer Upload Packet Response ID

ID	Description	CU Response
3‡	Packet out of order.	Restart transmission from the packet number included in the message.
4	Upload complete. Flash operations underway.	CU should cease transmission of packets until follow-up message is received.
5	Transfer CRC error.	CU should cease data transfer operations
6	Data length error.	CU should cease data transfer operations
8	Flash sector programming underway.	CU should stop transmitting packets and wait for follow-up messages.
9	Flash sector programming complete.	CU should resume transmission of packets.
10	Transfer complete.	CU should cease data transfer operations.

‡The TIM shall send this response to the CU any time it detects a gap in the packet number sequence. The packet number in the response shall be the packet number of the last packet received in the proper sequence.

3 OPERATIONAL COMMANDS

The operational commands are those used by the TIM during normal operations. These commands may also be used during factory calibration and testing.

3.1 SYSTEM COMMANDS

3.1.1 System Version Get – 0x07

Description: This command returns the system version. The response to the command is a series of TXT messages followed by an ACK message.

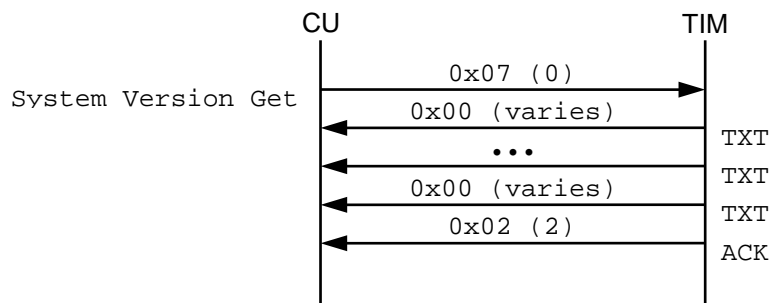


Figure 3– System Version Get Diagram

Command Format:

Table 25 – System Version Get Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x07	System Version Get Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

The TIM will respond with one or more TXT messages. Each TXT message shall contain a null-terminated string of less than 40 characters. The number of messages and their contents are system-specific... As an example, below are the version strings for Tamarisk[®]₆₄₀.

1. System Name – “System: Tamarisk-640”
2. CPU Software Version String – This is the version number of the current software release. Example format: “CPU Version: X1.P3.01.01.04”
3. Company Name – “DRS Technologies”

4. FPA Name – “FPA: U6160”
5. X1 Core Libraries Version – “X1 Core Lib Rel: 00.01.44”
6. RTL Logic Version String – This is the version number of the current RTL logic release. Example format: “RTL Rel: 01.00.0052”

Note: This is only an example. Some ASCII characters will change according to revision levels in the system.

The TXT messages shall be followed by an ACK message.

Table 26 – System Version Get TXT Response Format (Multiple Responses)

Byte	Value	Description
1	0x01	Start of message.
2	0x00	TXT Response
3	N	Parameters length.
4 to (N+3)	Zero-terminated text string	Length varies. Note trailing null is included in parameters length.
(N+4)	checksum	Frame check sequence.

Table 27 – System Version Get TXT Response Format (Multiple Responses Verbose Mode Enabled, Export Control 9-Hz Frame Rate Limited Mode)

Byte	Value	Description
1	0x01	Start of message.
2	0x00	TXT Response
3	N	Parameters length.
4 to (N+3)	Zero-terminated text string	Length varies. Note trailing null is included in parameters length. Example Response: “System: UC640-17” “Rel: X1.P3.01.06.06” “9Hz Enabled” “DRS Technologies” “FPA: U6160” “X1 Core Lib Rel: 00.00.00” “RTL Rel: 01.00.0066”
(N+4)	checksum	Frame check sequence.

Table 28 – System Version Get ACK Response Format

Byte	Value	Description
1	0x01	Start of message.

Byte	Value	Description
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0007	System Version Get Command ID.
6	checksum	Frame check sequence.

3.1.2 Customer Non-Volatile Read Command – 0xCA

Description: Allows a customer to read up to 252 ASCII characters. This information is read out of non-volatile memory and can be read back with the Customer Non-Volatile Read Command.

Command Format:

Table 29 – Customer Non-Volatile Read Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xCA	Customer Non Volatile Read Command ID.
3	0x00	Parameters length.
6	checksum	Frame check sequence.

Response Format:

Table 30 – Customer Non-Volatile Read Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	N	Parameters length, where $10 \leq N \leq 252$.
4 to (N+3)	varies	Non-volatile memory contents.
(N+4)	checksum	Frame check sequence.

3.1.3 Customer Non-Volatile Write Command – 0xCB

Description: Allows a customer to store up to 252 ASCII characters. This information is stored in non-volatile memory and can be written with the Customer Non-Volatile Write Command.

Command Format:

Table 31 – Customer Non-Volatile Write Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xCB	Customer Non-Volatile Write Command ID
3	N	Parameters length, where $10 \leq N \leq 252$.
4 to (N+3)	varies	Non-volatile memory contents.
(N+4)	checksum	Frame check sequence.

Response Format:

Table 32 – Customer Non-Volatile Write Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0027	Customer Non-Volatile Write Command ID.
6	checksum	Frame check sequence.

3.1.4 Enable Colorization Command – 0xCC*Description:* Enables colorization.*Command Format:*

Table 33 – Enable Colorization Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xCC	Enable Colorization Command ID.
3	0x02	Parameters length.
4, 5	0x0000 or 0x0001	0 disables colorization. 1 enables colorization.
6	checksum	Frame check sequence.

Response Format:

Table 34 – Enable Colorization Response Format

Byte	Value	Description
1	0x01	Start of message.

2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00CC	Colorization Enable Command ID.
6	checksum	Frame check sequence.

3.1.5 8-Bit Colorization Selection Command– 0xCD

Description: Allows the user to select the one of 12 different 8-bit colorization selections. Colorization must be enabled and the output video mode must be set to 8-bit.

Command Format:

Table 35 – 8-Bit Colorization Selection Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xCD	8-bit Colorization Command ID.
3	0x02	Parameters length.
4, 5	0x0000 to 0x000B	Selects one of 12 possible colorization pallets 0: White Hot 1: Black Hot 2: Red Light 3: Arcus 4: Inferno 5: SoftLight 6: Sunset 7: Memoriam 8: Flamma Arcticus 9: Ocean 10: Rain 11: Factory Default
6	checksum	Frame check sequence.

Response Format:

Table 36 – 8-Bit Colorization Selection Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00CD	8-Bit Colorization Selection Command ID.
6	checksum	Frame check sequence.

3.1.6 Video Orientation Select 0xCF

Description: Selects the video display output mode

Command Format:

Table 37 – Video Orientation Select Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xCF	Digital Video Source Select Command ID.
3	0x02	Parameters length.
4, 5	0 to 3	Video Orientation Selection 0 = Normal Orientation 1 = Vertical Invert 2 = Horizontal Invert 3 = Horizontal and Vertical Invert
6	checksum	Frame check sequence.

Response Format:

Table 38 – Video Orientation Select Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00CF	Video Orientation Source Select Command ID.
6	Checksum	Frame check sequence.

3.1.7 Digital Video Source Select – 0xD7

Description: Control the digital video output multiplexer. The camera default is to use the output of the AGC module.

Command Format:

Table 39 – Digital Video Source Select Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xD7	Digital Video Source Select Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer. See table below.	Source ID value.

6	checksum	Frame check sequence.
---	----------	-----------------------

Table 40 – Digital Video Source IDs

Source ID	Description
0	Test Pattern Generator
6	14 bit data with no invert/revert, no gray or freeze frame during auto-calibrations
7	14 bit data with 1 frame of latency with invert/revert, gray or freeze frame support during auto-calibrations
8	Output of AGC Module.
9	Output of Symbology Module.
All other values reserved.	

Response Format:

Table 41 – Digital Video Source Select Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00D7	Digital Video Source Select Command ID.
6	checksum	Frame check sequence.

3.1.8 Baud Rate Set – 0xF1

Description: Set the baud rate for the RS232 serial port. The system must be using RS-232 serial for this command to have an effect.



NOTE

Note: the baud rate for the USB port is fixed at 921600.

Note: there is no acknowledge of this command, any subsequent commands must be at the new baud rate.

The factory default setting is 57600 baud. There is a non-volatile parameter to permanently change this. If a different baud rate is desired, there must be an initial command to change the baud rate at 57600 baud. Or the non-volatile-parameter (#34) must be set to the desired baud rate.

Note: the baud rate for the USB port is fixed at 921600.

Command Format:

Table 42 – Baud Rate Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xF1	Baud Rate Set Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer. See table below.	Baud rate ID value.
6	checksum	Frame check sequence.

Table 43 – Baud Rate ID Values

Baud Rate ID	Baud Rate	Baud Rate ID	Baud Rate
0	230400	8	76800
1	115200	9	38400
2	57600	10	19200
3	28800	11	9600
4	14400	12	4800
5	7200	13	2400
6	3600	14	1200
7	1800	15	600

3.1.9 System Status Get – 0xF2

Description: This command requests system status. The response contains information about a variety of system functions...

Command Format:

Table 44 – System Status Get Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xF2	System Status Get Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Two responses are generated, a system status get response and an ACK response.

Table 45 – System Status Get First Response Format

Byte	Value		Description					
1	0x01		Start of message.					
2	0xF2		ACK Response					
3	0x10		Parameters length.					
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
4	(deprecated)		(deprecated)		EXTVID 0=in 1=out 2=off		CAL 0=none 1=2 pt cold 2=2 pt hot 3=1 pt 4=1 pt – no shutter	
5	AGC 0=off 1=log equal (auto) 2>manual 3=linear equal		(deprecated) Always reads 3		SHUTTE R 0=closed 1=open	(depre cated)	(depre cated)	POL 0=blk 1=wht
6			(deprecated) Always reads 0x0				(deprecated)	
7	Unsigned integer		Deprecated					
8, 9	Unsigned integer		Manual Gain					
10, 11	Unsigned integer		Manual Level					
12, 13	Unsigned integer		Gain Bias					
14, 15	Unsigned integer		Level Bias					
16, 17	Unsigned integer		Deprecated (always 0).					
18, 19	Unsigned integer		Deprecated (always 0).					
20	chksm		Frame check sequence.					

Table 46 – System Status Get ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response
3	0x02	Parameters length.
4, 5	0x00F2	System Status Get Command ID.
6	checksum	Frame check sequence.

Note the gain and level settings in response bytes 8 to 15 may be meaningless, depending on the specific AGC mode in use in byte 5.

3.2 FIELD CALIBRATION COMMANDS

Field calibrations may be performed at any time during camera operations to improve image quality. The most common is the 1-point calibration, wherein the shutter is closed, raw pixel samples are collected and averaged for some number of frames (default is 4), new NUC offsets are computed from the averaged samples, and the shutter is opened to resume operations.

The 1-point no shutter field calibration allows the camera to compute NUC offsets that compensate for lens non-uniformities. When this operation is performed, the camera should be pointed at a black body or suitable substitute that is at uniform temperature. The shutter is not operated during this operation and should be open prior to initiation.

3.2.1 Field Calibrate – 0x27

Description: Perform a calibration operation. The TIM supports several types of calibrations. Use this command to service pending calibrations, including range change, if Automatic Calibration Activity has been disabled.

Command Format:

Table 47 – Field Calibrate Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x27	Field Calibrate Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer. See table below.	Field calibration type ID value. Determines the type of field calibration to be performed.
6	checksum	Frame check sequence.

Table 48 – Field Calibrate Type IDs

ID	Description
3	1-point calibration.
4	1-point calibration with shutter disabled.
All other values reserved.	

Response Format:

Table 49 – Field Calibrate Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.

4, 5	0x0027	Field Calibrate Command ID.
6	checksum	Frame check sequence.

3.2.2 Field Calibrate – Shutter Disable Set – 0x81

Description: Enables or disables the TIM shutter. When the shutter is disabled it is forced closed and the shutter will ignore requests to open for field calibrations. When the shutter is enabled, it will open and respond to requests to open or close.

Command Format:

Table 50 – Field Calibrate Shutter Disable Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x81	Field Calibrate Shutter Disable Set Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer	0 = open and enable the shutter 1 = close and disable the shutter.
6	checksum	Frame check sequence.

Response Format:

Table 51 – Field Calibrate Shutter Disable Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0081	Field Calibrate Shutter Disable Set Command ID.
6	checksum	Frame check sequence.

3.2.3 Automatic Calibration Toggle – 0xAC

Description: Toggles the TIM between automatic or manual field calibration modes.

In automatic mode, a field calibration operation will occur at regular intervals.

In manual mode, a field calibration operation will only occur when commanded, other than range changes. A range change can occur as the camera temperature changes from one region to another. There are five temperature ranges; each range crossing has hysteresis so actual changes will depend on current range and next range. These field calibrations are required to maintain usable video.

The default is to have automatic calibration turned on.

Command Format:

Table 52 – Automatic Calibration Toggle Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xAC	Automatic calibration toggle command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Table 53 – Automatic Calibration Toggle Command Format (Option 2)

Byte	Value	Description
1	0x01	Start of message.
2	0xAC	Automatic calibration toggle command ID.
3	0x02	Parameters length.
4, 5	0x0000 or 0x0001	0 disables Autocal. 1 enables Autocal.
6	checksum	Frame check sequence.

Response Format:

Table 54 – Automatic Calibration Toggle Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response
3	0x02	Parameters length.
4, 5	0x00AC	Automatic calibration toggle command ID.
6	checksum	Frame check sequence.

3.2.4 Automatic Calibration Period Set – 0x12

Description: This command shall set the period between automatic calibrations (autocal period). This command does not store the autocal period in non-volatile storage to be preserved across power cycles. A setting of zero (0) is will prevent only periodic automatic calibrations, not all automatic calibrations.

The default for time based automatic calibrations is five minutes.

Command Format:

Table 55 – Automatic Calibration Period Set Command Format

Byte	Value	Description
1	0x01	Start of message.

Byte	Value	Description
2	0x12	Automatic calibration period set command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer	Automatic calibration period in minutes.
6	checksum	Frame check sequence.

Response Format:

Table 56 – Automatic Calibration Period Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0012	Automatic calibration period set command ID.
6	checksum	Frame check sequence.

3.2.5 Automatic Calibration Period Get – 0x13

Description: This command shall retrieve the period between automatic calibrations (autocal period).

Command Format:

Table 57 – Automatic Calibration Period Get Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x13	Automatic calibration period get command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 58 – Automatic Calibration Period Get TXT Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x00	TXT Response
3	N	Parameters length.
4 to	Zero-terminated	Message content example:

Byte	Value	Description
(N+3)	text string	Example: "AUTOCAL: Interval= 300 sec." Note trailing null is included in parameters length.
(N+4)	checksum	Frame check sequence.

Table 59 – Automatic Calibration Period Get ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0013	AutoCal Period Get Command ID.
6	checksum	Frame check sequence.

3.2.6 Automatic Calibration Activity Control – 0x26

Description: This command shall control whether all automatic calibrations (autocal, including range changes) are enabled or disabled. This command does not store calibration activity mode in the NV Param. See section 3.5 for storing in NV Param.



NOTE

Customers disabling automatic field calibrations must use command 0x25 Automatic Calibration Pending Activity Query and allow some calibrations to maintain image and uniformity.

Command Format:

Table 60 – Automatic Calibration Activity Control Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x26	AutoCal Activity Control command ID.
3	0x02	Parameters length.
4, 5	0x0000 or 0x0001	Enable (0x0001) or Disable (0x0000)
6	checksum	Frame check sequence.

Response Format:

Table 61 – Automatic Calibration Activity Control ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0026	AutoCal Activity Control Command ID.
6	checksum	Frame check sequence.

3.2.7 Automatic Calibration Pending Activity Query – 0x25

Description: This command queries the camera for pending Automatic Calibration activities, and specifies the type of AutoCal that is pending. A suggested interval for checking for pending calibration requests is every 5 minutes during normal operation and every one (1) minute for the first ten (10) minutes immediately following power-up.

Command Format:

Table 62 – Automatic Calibration Pending Activity Query Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x25	AutoCal Pending Activity Query command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 63 – Automatic Calibration Pending Activity Query VALUE Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x45	VALUE Response
3	0x02	Parameters length.
4, 5	Unsigned int	Type of Calibration Pending: 0: None. 1: Periodic Time-out. 2: Range Change.
6	checksum	Frame check sequence.

Table 64 – Automatic Calibration Pending Activity Query ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0025	AutoCal Pending Activity Query command ID.
6	checksum	Frame check sequence.

3.3 AGC COMMANDS

The system supports both conventional AGC operation and Image Contrast Enhancement (ICE) operation. These operating modes are mutually exclusive.

The AGC module converts 14-bit video data to 8-bit data. The AGC has several operating modes that control how this conversion takes place. Generally, a histogram of the input data is computed, upper and lower limits of useful video data are extracted (black limit and white limit), and a contrast stretch between those levels is performed. Two histogram equalization modes are supported, AGC freeze and log2. The camera default is log2 mode. If the user has set the video tap to pre-AGC these commands have no effect on the output video stream.

In addition, the system supports an Image Contrast Enhancement (ICE) mode. When enabled, the normal AGC operation is disabled and ICE operation takes its place. ICE operation also converts 14-bit video data to 8-bit data, however, it does so in a way that details can be seen in the video that would not otherwise be visible in AGC mode. The resulting video is generally superior to that of AGC mode.

3.3.1 ICE Mode Min-Max Command – 0x22 (formerly known as ICE Mode Contrast Stabilization - Deprecated, please use command 0x1E for ICE adjustments)

Camera RTL Rel version 01.00.3532 or newer is required together with compatible CPU(Rel) version.

Description: ICE Mode Min-Max command provides backward compatibility with previous ICE version using Indoor and Outdoor mode and sets the ICE strength to its minimum or maximum level.

Command Format:

Table 65 – ICE Mode Min-Max Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x22	ICE Mode Min-Max Command ID.
3	0x02	Parameters length.
4, 5	0x0000 or 0x0001	0 preset value for low strength

		1 preset value for high strength
--	--	----------------------------------

Response Format:

Table 66 – ICE Mode Min-Max Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0022	ICE Mode Min-Max Command ID.
6	checksum	Frame check sequence.

3.3.2 ICE Mode Enable Command – 0x23

Camera RTL Rel version 01.00.3532 or newer is required together with compatible CPU(Rel) version.

Description: Enables and disables Image Contrast Enhancement (ICE) Mode.

Command Format:

Table 67 – ICE Mode Enable Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x23	Enable ICE Command ID.
3	0x02	Parameters length.
4, 5	0x0000 or 0x0001	0 disables ICE mode. 1 enables ICD mode.
6	checksum	Frame check sequence.

Response Format:

Table 68 – ICE Mode Enable Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0023	ICE Enable Command ID.
6	checksum	Frame check sequence.

3.3.1 ICE Mode Strength Command – 0x1E

Camera RTL Rel version 01.00.4471 or newer is required.

Description: Sets ICE Strength. (ICE Mode must be enabled before this command will have any effect). This command, enables the user to select an ICE strength from 0-7 in 1 unit increments. The lowest setting is 0; the highest setting is 7. Recommend using lower values when looking at lower contrast scenes and higher values when looking at dynamic scenes.

Command Format:

Table 69 – ICE Mode Strength Command Format

2	0x1E	ICE Mode Strength Command ID.
3	0x02	Parameters length.
4, 5	0x0000...0x0007	ICE Strength value.
6	checksum	Frame check sequence.

Response Format:

Table 70 – ICE Mode Strength Response Format

4, 5	0x001E	ICE Mode Strength Command ID.
6	checksum	Frame check sequence.

3.3.2 ICE Mode High-Frequency Threshold Command – 0x1F (Deprecated, please use command 0x1E for ICE adjustments)

Camera RTL Rel version 01.00.4189 or newer is required together with compatible CPU(Rel) version.

Description: This command is preserved for backward compatibility with previous ICE implementation and maps the 0-1023 input scale to the new ICE strength scale found in cmd 0x1E.

Command Format:

Table 71 – ICE Mode High-Frequency Threshold Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x1F	ICE Mode High-Frequency Threshold Command ID.
3	0x02	Parameters length.
4, 5	0 to 1023	ICE high-frequency threshold value.
6	checksum	Frame check sequence.

Response Format:

Table 72 – ICE Mode High-Frequency Threshold Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x001F	ICE Mode High-Frequency Threshold Command ID.
6	checksum	Frame check sequence.

3.3.3 AGC Mode Set – 0x2A

Description: Sets the operating mode for Automatic Gain Control.



NOTE

This command has no effect if ICE is enabled.

Command Format:

Table 73 – AGC Mode Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x2A	AGC Mode Set Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer. See table below.	AGC Mode ID value.
6	checksum	Frame check sequence.

Table 74 – AGC Mode ID Values

AGC Mode ID	AGC Mode
0	AGC Freeze – AGC conversion is frozen at current gain and level.
1	Log2 Histogram Equalization (also called “auto”)
2	Manual Mode
	All other values reserved

Response Format:

Table 75 – AGC Mode Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x002A	AGC Mode Set Command ID.
6	checksum	Frame check sequence.

3.3.4 AGC Black-Hot Polarity Set – 0x28

Description: Commands the system to display hotter objects in the image as darker (blacker) and cooler objects as lighter. The default camera setting is white hot.

Command Format:

Table 76 – AGC Black-Hot Polarity Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x28	Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 77 – AGC Black-Hot Polarity Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0028	AGC Mode Command
6	checksum	Frame check sequence.

3.3.5 AGC White-Hot Polarity Set – 0x29

Description: Commands the system to display hotter objects in the image as lighter (whiter) and cooler objects as darker. This is the default.

Command Format:

Table 78 – AGC White Hot Polarity Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x29	AGC White-Hot Polarity Set Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 79 – AGC White Hot Polarity Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0029	AGC White-Hot Polarity Set Command ID.
6	checksum	Frame check sequence.

3.3.6 AGC Manual Gain Set – 0x32

Description: Sets gain value used by AGC when configured to Manual Mode.

**NOTE**

This command has no effect if ICE is enabled.

Command Format:

Table 80 – AGC Manual Gain Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x32	AGC Manual Gain Set Command ID.
3	0x02	Parameters length.
4,5	unsigned integer 0 to 4095	AGC manual gain value. $gain = 256 / (4096 - manual_gain_value)$ 0 = minimum gain, gain = 1/16 (.0625) 3840 (4095 – 255) = unity gain, gain = 1.0 4095 (0x0FFF) = maximum gain, gain = 256

6	checksum	Frame check sequence.
---	----------	-----------------------

Response Format:

Table 81 – AGC Manual Gain Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0032	AGC Manual Gain Set Command ID
6	checksum	Frame check sequence.

3.3.7 AGC Manual Level Set – 0x33

Description: Sets level value used by AGC when configured to Manual Mode.



NOTE

This command has no effect if ICE is enabled.

Command Format:

Table 82 – AGC Manual Level Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x33	AGC Manual Level Set Command ID.
3	0x02	Parameters length.
4,5	unsigned integer 0 to 4095	AGC manual level value. 0 = minimum level 4095 (0x0FFF) = maximum level
6	checksum	Frame check sequence.

The minimum and maximum pixel values (X0 and X1) that the AGC will display are centered around the manual level value. The separation between X0 and X1 is determined by the manual gain value. X0 and X1 are calculated as follows:

$$X0 = \text{level} + \text{ceil} (-(4095 - \text{gain})/2)$$

$$X1 = \text{level} + \text{ceil} ((4095 - \text{gain})/2) + 1$$

Response Format:

Table 83 – AGC Manual Level Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0033	AGC Manual Level Set Command ID
6	checksum	Frame check sequence.

3.3.8 AGC Gain Bias Set – 0x82

Description: Sets gain bias value. Gain bias is similar to a contrast control.

Command Format:

Table 84 – AGC Gain Bias Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x82	AGC Gain Bias Set Command ID.
3	0x02	Parameters length.
4,5	unsigned integer 0 to 4095	AGC gain bias value. 0 = minimum gain bias, gain factor = 0.25 2047 (0x7FF) = unity gain bias, gain factor = 1.0 4095 (0x0FFF) = maximum gain bias, gain factor = 4.0
4	checksum	Frame check sequence.

Response Format:

Table 85 – AGC Gain Bias Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0082	AGC Gain Bias Set Command ID
6	checksum	Frame check sequence.

The gain factor computed for each bias setting is a two - piece formula.

For gain_bias <= 2047, gain_factor = (0.75*gain_bias/2047)+0.25

For gain_bias >= 2048, gain_factor = (3*(gain_bias-2048)/2047)+1

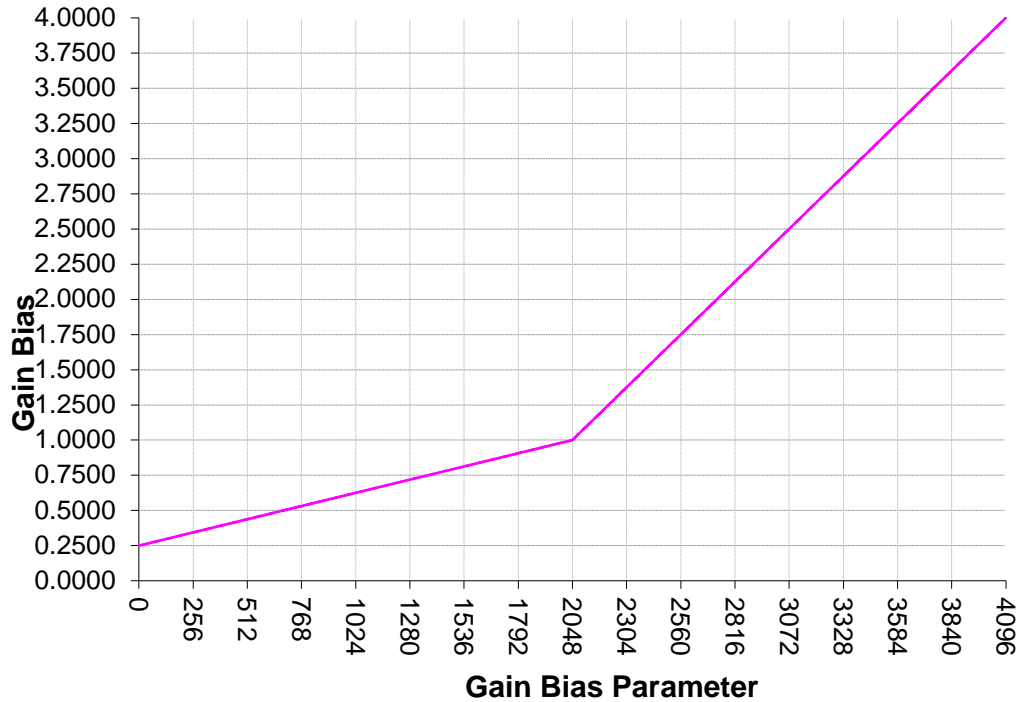


Figure 4– Gain Factor Curve

3.3.9 AGC Level Bias Set – 0x83

Description: Sets level bias value. Level bias is similar to a brightness control.

Command Format:

Table 86 – AGC Level Bias Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x83	AGC Level Bias Set Command ID.
3	0x02	Parameters length.
4,5	unsigned integer 0 to 4095	AGC gain bias value. 0 = minimum level bias, level factor = -255 2047 (0x7FF) = unity level bias, gain factor = 0 4095 (0x0FFF) = maximum level bias, gain factor = 255
4	checksum	Frame check sequence.

For level bias ≤ 2047 , level_factor = $255 * \text{level_bias} / 2047 - 255$

For level bias ≥ 2048 , level factor = $255 * (\text{level_bias} - 2047) / 2048$

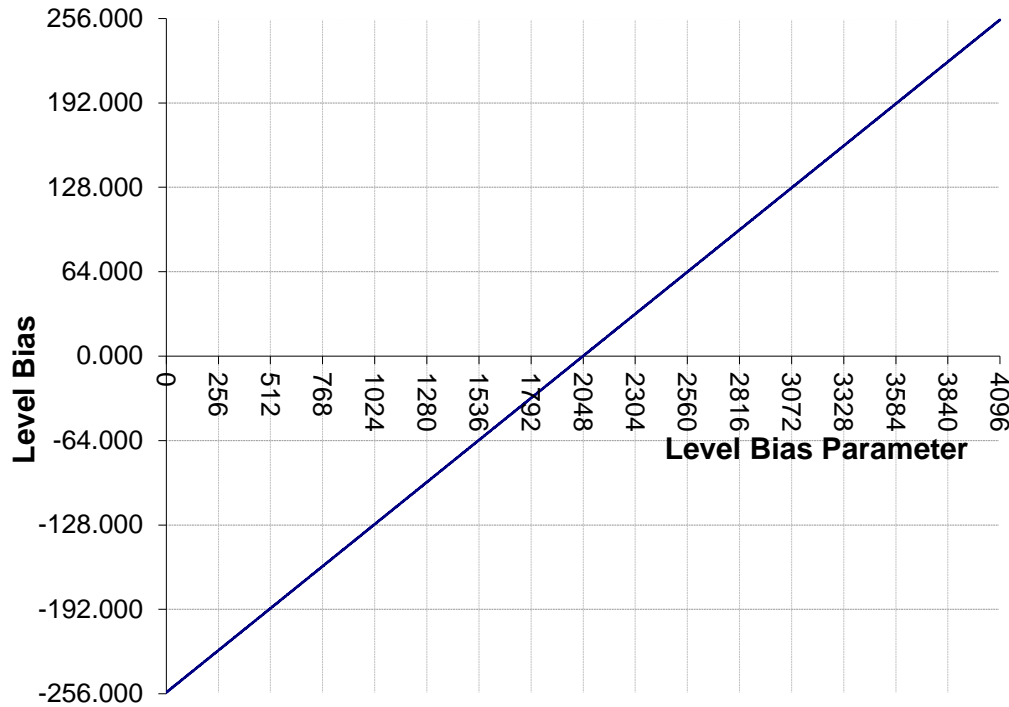


Figure 5– Level Bias Chart

Response Format:

Table 87 – AGC Level Bias Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0083	AGC Level Bias Set Command ID.
6	checksum	Frame check sequence.

3.3.10 AGC Gain Limit Set – 0xD1

Description: The AGC Gain Limit and the AGC Gain Limit Noise Reduction Mode are two independent blocks which control the AGC gain limit

The AGC Gain Limit Set command allows the user to configure the minimum allowable difference between the white limit and black limit for AGC histogram processing. A smaller value allows the maximum gain to be higher (e.g., allows a smaller difference between the black limit and the white limit). In low-contrast scenes, this smaller value will

allow more sensitivity but will also gain-up any system noise. A larger value will prevent objectionable gaining-up of system noise but will reduce sensitivity in low-contrast scenes.

The AGC Gain Limit Noise Reduction Mode (which is an NV parameter) works to limit the pixel-to-pixel difference and thus reducing the effects of noise across the entire scene. This limit has the effect of smoothing out the image and hence the AGC provides a better overall image.

It is possible (but not recommended) to enable both the AGC Gain Limit and the AGC Gain Limit Noise Reduction mode. By default the AGC Gain limit is disabled and the AGC Gain Limit Noise Reduction mode is enabled.



NOTE

This command has no effect if ICE is enabled.

Command Format:

Table 88 – AGC Gain Limit Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xD1	AGC Gain Limit Set Command ID.
3	0x02	Parameters length.
4,5	unsigned integer 0 to 4095	AGC gain limit value. 0 = gain limiting disabled 32 = gain limited to gain factor = 4.0 64 = gain limited to gain factor = 3.0 128 = gain limited to gain factor = 2.0 256 = gain limited to gain factor = 1.0 4095 (0x0FFF) = maximum (not recommended)
4	checksum	Frame check sequence.

Response Format:

Table 89 – AGC Gain Limit Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00D1	AGC Gain Limit Set Command ID.
6	checksum	Frame check sequence.

3.3.11 AGC Gain Flatten Offset Set – 0xD2

Description: Sets the gain limit offset for AGC histogram processing. The default value is 1.



NOTE

This command has no effect if ICE is enabled.

Command Format:

Table 90 – AGC Gain Flatten Offset Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xD2	AGC Gain Flatten Offset Set Command ID.
3	0x02	Parameters length.
4, 5	unsigned integer 0 to 65535	AGC gain flatten offset value.
6	checksum	Frame check sequence.

Response Format:

Table 91 – AGC Gain Flatten Offset Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00D2	AGC Gain Flatten Offset Set Command ID.
6	checksum	Frame check sequence.

3.3.12 AGC Region of Interest – 0x84

Description: Sets or gets the AGC Region of Interest (ROI). This command also returns the allowable ROI Limit. This command also provides ability to burn all of the ROI to flash NV Param.



NOTE

This command has no effect if ICE is enabled.

Sub Command Format:

Table 92 – AGC Region of Interest Sub Command Table

ID	Description	Additional Parameters	Response
0	Get ROI	None	Text String, ACK
1	Get ROI Limit	None	Text String, ACK
2	Set ROI	4 unsigned integer	ACK
3	Burn ROI to NV Param	None	ACK
All other values reserved.			

Command Format (sub-command 0x0000, Get):

Table 93 – AGC ROI Get Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x84	AGC ROI Get Command ID.
3	0x02	Parameters length.
4,5	0x0000	Sub-command Get ROI.
6	checksum	Frame check sequence.

Response Format:

Table 94 – AGC ROI Command ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x84	AGC ROI Get Command ID.
6	checksum	Frame check sequence.

Table 95 – AGC ROI Get Response 1 Format

Byte	Value	Description
1	0x01	Start of message.
2	0x00	Text message.
3	0x39	Parameters length.
4-56	Zero-terminated string.	Example: "AGC ROI (x0,y0,x1,y1): (0, 0, 639,479)" (Each coordinate value takes up 3 characters).
57	checksum	Frame check sequence.

Command Format (sub-command 0x0001, Get Limit):

Table 96 – AGC ROI Get Limit Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x84	AGC ROI Get Limit Command ID.
3	0x02	Parameters length.
4,5	0x0001	Sub-command Get Internal ROI Limit.
6	checksum	Frame check sequence.

Response Format:

Table 97 – AGC ROI Get Limit Response 1 Format

Byte	Value	Description
1	0x01	Start of message.
2	0x00	Text message.
3	0x39	Parameters length.
4-56	Zero-terminated string.	Example: "AGC ROI (x0,y0,x1,y1): (0, 0, 639, 479)" (Each coordinate value takes up 3 characters).
57	checksum	Frame check sequence.

Table 98 – AGC ROI Get Limit Command ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x84	AGC ROI Get Limit Command ID.
6	checksum	Frame check sequence.

Command Format (sub-command 0x0002, Set):

Table 99 – AGC ROI Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x84	AGC ROI Set Command ID.
3	0x0A	Parameters length.
4, 5	0x0002	Sub-command Set ROI.
6, 7	Unsigned integer	XSTART, within valid limits (see Get Limit)
8, 9	Unsigned integer	YSTART, within valid limits (see Get Limit)

10, 11	Unsigned integer	XSTOP, within valid limits (see Get Limit)
12, 13	Unsigned integer	YSTOP, within valid limits (see Get Limit)
14	checksum	Frame check sequence.

Response Format:

Table 100 – AGC ROI Set Command ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x84	AGC ROI Set Command ID.
6	checksum	Frame check sequence.

Command Format (sub-command 0x0003, Burn to NV Param):

Table 101 – AGC ROI Burn to NV Params Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x84	AGC ROI Burn to NV Params Command ID.
3	0x02	Parameters length.
4, 5	0x0003	Sub-command Burn ROI to NV Param.
6	checksum	Frame check sequence.

Response Format:

Table 102 – AGC ROI Burn to NV Params Command ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x84	AGC ROI Burn to NV Params Command ID.
6	checksum	Frame check sequence.

3.3.13 AGC Options Set – 0xA0

Description: Sets AGC LUT limits.

**NOTE**

This command has no effect if ICE is enabled.

Command Format:

Table 103 – AGC Options Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xA0	AGC Options Set Command ID.
3	0x02	Parameters length.
4, 5	0x000A	AGC gain flatten offset value.
6, 7	unsigned integer 0 to 65535	Pixel sum upper bound.
8, 9	unsigned integer 0 to 65535	Pixel sum lower bound.
10	checksum	Frame check sequence.

Response Format:

Table 104 – AGC Options Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00A0	AGC Options Set Command ID.
6	checksum	Frame check sequence.

3.4 ZOOM COMMANDS

3.4.1 Zoom Magnification Set – 0xA4

Description: Selects zoom magnification.

Command Format:

Table 105 – Zoom Magnification Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xA4	Zoom Magnification Set Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer. See table below.	Zoom magnification ID value.
6	checksum	Frame check sequence.

Table 106 – Zoom Magnification ID Values

Zoom Magnification ID	Zoom		
0	1.00	7	2.75
1	1.25	8	3.00
2	1.50	9	3.25
3	1.75	10	3.50
4	2.00	11	3.75
5	2.25	12	4.00
6	2.50	-	-

Response Format:

Table 107 – Zoom Magnification Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00A4	Zoom Magnification Set Command ID.
6	checksum	Frame check sequence.

3.4.2 Zoom Pan Set – 0xA5

Description: Selects the origin from within the un-zoomed, original image for the zoomed image subset. The origin is the zero-based offset of the center of the zoomed image. The offset [0,0] is the center of the un-zoomed image.

Command Format:

Table 108 – Zoom Pan Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xA5	Zoom Pan Set Command ID.
3	0x04	Parameters length.
4, 5	Signed integer	Horizontal offset from the center. Negative values center the zoom to the left of FPA center. Positive values center the zoom to the right of FPA center.
6, 7	Signed integer.	Vertical offset from the center. Negative values center the zoom above the FPA center. Positive values center the zoom below the FPA center.
6	checksum	Frame check sequence.

Response Format:

Table 109 – Zoom Pan Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00A5	Zoom Pan Set Command ID.
6	checksum	Frame check sequence.

3.4.3 Zoom Store Current Settings – 0xA6

Description: Permanently stores current zoom settings in Non-volatile memory.

Command Format:

Table 110 – Zoom Store Current Settings Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xA6	Zoom Store Current Settings Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 111 – Zoom Store Current Settings Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00A6	Zoom Pan Set Command ID.
6	checksum	Frame check sequence.

3.5 NON-VOLATILE PARAMETERS COMMANDS

The following table lists the non-volatile commands available to the camera user.

Table 112 – Non-Volatile Parameter IDs

ID	Name	Type	Values	Default Value	Notes
1	RS170 Mode Select	Integer	0=NTSC 1=PAL-M 2=PAL-N 3=PAL-BDGHIN2	0	
2	RS170 Invert Enable	Boolean	0=disable non-zero=enable	0	Used to vertically invert the analog video output
3	RS170 Revert Enable	Boolean	0=disable non-zero=enable	0	Used to horizontally invert the analog video output
4	RS170 Output Enable	Boolean	0=disable non-zero=enable	1	The Parallel digital output and the the RS170 share pins. If both are enabled on power-up, RS170 will be output. If both are enabled during operation, the most recent will be used.
5	Parallel Digital Video Output Enable	Boolean	0=disable non-zero=enable	1	The Parallel digital output and the RS170 share pins. If both are enabled on power-up, RS170 will be output. If both are enabled during operation, the most recent will be used.
6	Camera Link Output Enable	Boolean	0=disable non-zero=enable	1	

ID	Name	Type	Values	Default Value	Notes
7	Video Output Mux Select	Unsigned integer	0 = Output of Uploaded Test Pattern 6 = 14 bit data with no invert/revert, no gray or freeze frame during auto-calibrations 7 = 14 bit data with 1 frame of latency with invert/revert, gray or freeze frame support during auto-calibrations 8 = AGC 9 = Symbology All other values reserved.	9	The output of the selected processing block will be output to all video output ports (RS170, parallel digital video, and Camera Link).
8	AGC Gain Limit	Unsigned integer	0 to 4095	0	This has no effect unless parameter 36 is maximum value 0x0FFF
9	AGC Gain Flatten Offset	Unsigned integer	0 to 65535	3	
11	AGC Upper/Lower Bounds Percent	Unsigned integer	0 to 100 (%).	1	
14	Automatic Field Calibration Interval	Unsigned integer	1 to 65535 minutes	5	Interval between automatic field calibrations. Setting this value to 0 will disable time-based automatic calibrations (not all calibrations will be disabled). This value must be greater than the minimum Autocal interval.
16	Frame Rate	Unsigned integer	1 = 30 hz 2 = 24 hz 3 = 18 hz 4 = 15 hz 5 = 12 hz 6 = 9 hz 7 = 6 hz 8 = 3 hz All other values reserved.	1 or 6	A 30 Hz camera can be set to any supported lower frame rate. A 9 Hz camera can only be set to 9 Hz.
17	Genlock Enable	Boolean	0 = disabled non-zero = enabled	0	

ID	Name	Type	Values	Default Value	Notes
18	Genlock Master Enable	Boolean	0 = slave mode non-zero = master mode	0	This value has no effect when GENLOCK is disabled.
19	Genlock Delay	Unsigned integer	0 to 255 clocks.	0	The number of system clocks to delay the generated Genlock signal when enabled and in master mode. "0" is no delay. This value has no effect when GENLOCK is disabled.
34	Serial Port Baudrate	Unsigned integer	See Serial Baudrate command in Section 3.1.9 for complete listing of selectable baudrates.	2	Default power-on serial communication baudrate.
35	AutoCal Activity Control	Boolean	0: Disable 1: Enable	1	Controls whether AutoCal activities, including range change are allowed after power-up. Note: Power-up 1-Pt is always performed to provide best initial image.
36	AGC Gain Limit Noise Reduction Mode	Unsigned fixed-point integer	0x0010: Enable 0x0FFF: Disable	0x0010	Controls the AGC Noise Reduction Gain Factor. Set to 0x0FFF to disable noise reduction mode.
38	AGC Black Hot Enable at Power Up	Boolean	0: Disable 1: Enable	0	Value is applied only at the time of power up.
39	AGC Auto Mode Gain Bias at Power Up	Unsigned integer	0-4096	2047	Value is applied only at the time of power up.
40	AGC Auto Mode Level Bias at Power Up	Unsigned integer	0-4096	2047	Value is applied only at the time of power up.
41	AGC Manual Mode Gain at Power Up	Unsigned integer	0-4096	3840	Value is applied only at the time of power up.
42	AGC Manual Mode Level at Power Up	Unsigned integer	0-4096	2047	Value is applied only at the time of power up.
43	AGC Mode at Power Up	Unsigned integer	0: Freeze/Off 1: Auto Mode 2: Manual Mode	1	Value is applied only at the time of power up.

ID	Name	Type	Values	Default Value	Notes
45	8-Bit Colorization Selection	Unsigned integer	0: White Hot 1: Black Hot 2: Red Light 3: Arcus 4: Inferno 5: SoftLight 6: Sunset 7: Memoriam 8: Flamma Arcticus 9: Ocean 10: Rain 11: Factory Default	11	Value is applied only at the time of power up.
46	Enable Colorization	Boolean	0: Disable 1: Enable	0	Value is applied only at the time of power up.
47	ICE Mode Enable	Boolean	0: Disable 1: Enable	1	Value is applied only at the time of power up.
48	Frame Buffer Video Suspend Action	Unsigned integer	0 = freeze video 1 = output gray value	0	What happens to the video when a 1-point event happens
49	Video Suspend Gray Value	Unsigned integer	0 (black) to 16383 (white)	8192	This has no effect with the Frame Buffer Video Suspend Action (Non-Volatile is set to Freeze Video)
52	Symbology Enable	Boolean	0: Disable 1: Enable	0	This must be enabled in conjunction with the specific NV param for the symbology to show on screen. For example, NVParam 52 must be set to 1 and NVParam 55 must be set to 1 for the polarity symbology to show. If either is set to 0, then the polarity symbology is not displayed.
53	Symbology 1-point Display Indication	Unsigned integer	0 = Disabled > 0, Enabled duration in seconds	0	Cannot be larger than 0xFFFF. NVParam 52 must also be enabled.
54	Symbology Enable DRS Logo	Boolean	0: Disable 1: Enable	0	NVParam 52 must also be enabled.
55	Symbology Polarity Enable	Boolean	0: Disable 1: Enable	0	NVParam 52 must also be enabled.

ID	Name	Type	Values	Default Value	Notes
56	Symbology Start Up Time Duration	Unsigned integer	0 = Disabled > 0, Enabled duration in seconds	0	Cannot be larger than 0xFFFF. NVPParam 52 must also be enabled.
57	Symbology Zoom Enable	Boolean	0: Disable 1: Enable	0	NVPParam 52 must also be enabled.
58	AGC ROI Starting Column	Unsigned integer	0-639	0	Cannot be larger than or equal to Ending Column.
59	AGC ROI Starting Row	Unsigned integer	0-479	0	Cannot be larger than or equal to Ending Row.
60	AGC ROI Ending Column	Unsigned integer	0-639	319	Cannot be smaller than or equal to Starting Column.
61	AGC ROI Ending Row	Unsigned integer	0-479	232	Cannot be smaller than or equal to Starting Row.
63	Lens Calibration Enable	Boolean	0: Disable 1: Enable	0	Value is applied only at the time of power up.
64	Lens Calibration Table Selection	Unsigned integer	Table 1 = 0x0000 Table 2 = 0x0001 Table 3 = 0x0002 Table 4 = 0x0003 Table 5 = 0x0004	0	Not Valid unless the lens calibration is enabled
65	ICE Mode Min-Max On	Boolean	0 preset value for low strength 1 preset value for high strength	0	ICE must be enabled for this parameter to have any effect. ICE can be enabled at power-up with parameter 47. <i>Camera RTL Rel version 01.00.3532 or newer is required together with compatible CPU(Rel) version.</i> Deprecated, please use parameter 79 for ICE strength adjustments
66	Symbology Field Calibration Enable	Boolean	0 = disabled non-zero = enabled	0	

ID	Name	Type	Values	Default Value	Notes
67	Zoom Magnification Power on Value	Unsigned integer	0 = 1.00X 1 = 1.25X 2 = 1.50X 3 = 1.75X 4 = 2.00X 5 = 2.25X 6 = 2.50X 7 = 2.75X 8 = 3.00X 9 = 3.25X 10 = 3.50X 11 = 3.75X 12 = 4.00X	0	
68	Zoom Horizontal Offset Power On Value	Signed Integer	Horizontal offset from the center. - Negative values center the zoom to the left of FPA center. - Positive values center the zoom to the right of FPA center. - Range depends on power-on zoom magnification. - Values out of range will be clipped at maximum.	0	
69	Zoom Vertical Offset Power On Value	Signed Integer	Vertical offset from the center. - Negative values center the zoom above the FPA center. - Positive values center the zoom below the FPA center. - Range depends on power-on zoom magnification. - Values out of range will be clipped at maximum.	0	
71	ICE Power-On Slope Limit	Unsigned Integer	1 to 63, where: 1 = 0.25 2 = 0.50 ... 8 = 2.00 ... 63 = 15.75	8	<i>Camera RTL Rel version 01.00.3532 or newer is required together with compatible CPU(Rel) version.</i> <i>Deprecated, please use parameter 79 for ICE strength adjustments</i>
72	Crosshairs Enable	Boolean	0 = disabled non-zero = enabled	0	

ID	Name	Type	Values	Default Value	Notes
73	Crosshairs Border Enable	Boolean	0 = disabled non-zero = enabled	0	Enabling this parameter does nothing unless parameter 72 is also enabled.
74	Crosshairs X Location	Unsigned integer	6 to 632	320	Values outside of allowable range will be truncated to nearest legal value.
75	Crosshairs Y Location	Unsigned integer	6 to 472	240	Values outside of allowable range will be truncated to nearest legal value.
76	YUV Output (Superframe) Enable	Boolean	0 = disabled non-zero = enabled	0	<i>Camera RTL Rel version 01.00.3995 or newer is required together with compatible CPU(Rel) version.</i>
77	ICE High-Frequency Threshold	Unsigned Integer	0 to 1023	1023	<i>Camera RTL Rel version 01.00.4189 or newer is required. This parameter is preserved for backward compatibility together with previous ICE implementation; these values are automatically mapped to new ICE Strength settings 0-7. See Parameter compatible CPU(Rel) version. Deprecated, please use parameter 79 for ICE strength adjustments</i>
78	Frame Buffer Enable	Boolean	0 = disabled non-zero = enabled	1	Disabling frame buffer reduces system latency by one frame. ICE will not function with frame buffer disabled.
79	ICE Strength	Unsigned Integer	0-7	3	ICE must be enabled for this parameter to have any effect. ICE can be enabled at power-up with parameter 47. This cmd sets desired ICE strength. <i>Camera RTL Rel version 01.00.4471 or newer is required</i>
All other values reserved					

3.5.1 Non-Volatile Parameters Default Set – 0xB3

Description: Load the default non-volatile parameters. Please note:

1. This command causes one or more sectors of flash memory on the TIM to be erased and reprogrammed. See general notes on command timing.
2. If flash is successfully reprogrammed, this command results in an ACK message.

- If flash programming fails, this command results in an ERR response containing an informative string.



WARNING

This command will reset the camera back to factory defaults, any customer non-volatile parameter changes will be lost (this will not effect customer flash sector or customer dead cell map).

Command Format:

Table 113 – Non-Volatile Parameters Default Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xB3	Non-Volatile Parameters Set Default Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 114 – Non-Volatile Parameters Default Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00B3	Non-Volatile Parameters Set Default Command ID.
6	checksum	Frame check sequence.

3.5.2 Non-Volatile Parameters Get – 0xB5

Description: Displays the value of the selected Non-Volatile Parameter

Command Format:

Table 115 – Non-Volatile Parameters Get Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xB5	Non-volatile parameters get command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer	Non-volatile parameter ID.
6	checksum	Frame check sequence.

Response Format:

This command generates two response messages. The first is a VALUE message that contains the value of the non-volatile parameter. The second response is an ACK message.

Table 116 – Non-Volatile Parameters Get VALUE Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x45	VALUE Response
3	0x02	Parameters length.
4, 5	Unsigned int	Non-volatile parameter value.
6	checksum	Frame check sequence.

Table 117 – Non-Volatile Parameters Get ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00B5	Non-volatile parameters get command ID.
6	checksum	Frame check sequence.

3.5.3 Non-Volatile Parameters Set – 0xB0

Description: Set a non-volatile parameter. The parameter will effect camera operation immediately – it is not necessary to cycle the TIM's power. Please note:

1. This command causes one or more sectors of flash memory on the TIM to be erased and reprogrammed. See general notes on command timing.
2. If flash is successfully reprogrammed, this command results in an ACK message.
3. If flash programming fails, this command results in an ERR response containing an informative string.

Command Format:

Table 118 – Non-Volatile Parameters Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xB0	Non-volatile parameters set command ID.
3	0x04	Parameters length.
4, 5	Unsigned integer	Non-volatile parameter ID.
6, 7	Unsigned integer	New non-volatile parameter value.

8	checksum	Frame check sequence.
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Parameter Value size and content are dependent on parameter ID. Two types are common:

- ◆ Boolean – a 16-bit unsigned integer where:
 - 0 = disabled
 - 1 = enabled.
- ◆ Unsigned integer – a 16-bit value whose range is parameter specific.
- ◆ Response Format:

Table 119 – Non-Volatile Parameters Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response
3	0x02	Parameters length.
4, 5	0x00B0	Non-volatile parameters set command ID.
6	checksum	Frame check sequence.

3.6 PIXEL MAP COMMANDS

The defective pixel map identifies Focal Plane Array (FPA) pixels that are stuck high, stuck low, flashing, or otherwise defective. Pixels identified in the map are replaced with a filtered average of neighboring pixels.

The Thermal Imaging Module (TIM) includes a cursor function that facilitates identifying defective pixels. When the cursor is enabled, a single FPA pixel is replaced with a cursor value. The cursor position may be relocated within the FPA as desired. The cursor value may be either maximum hot (a white pixel) or maximum cold (a black pixel). The cursor value may be switched as desired to improve its visibility on the scene.

Most of the defective pixel map commands require parameters consisting of a row and column index. Row index 0 is the upper row of the FPA. The row index must be less than height of the FPA in pixels. If the row index is out of range, the command will result in an error message.

Column index 0 is the left-most column of the FPA. The column index must be less than the width of the FPA. If the column index is out of range, the command will result in an error message.

The commands in this section modify the active defective pixel map in DDR memory. None of these commands modify the defective pixel map in non-volatile memory. If the modified pixel map is to be used following a power cycle, the map must be burned to non-volatile flash with the Flash Region Program From Active DDR Region (0xFB) command.

3.6.1 Defective Pixel Map Cursor Enable – 0x38

Description: Enables or disables the defective pixel cursor.

Command Format:

Table 120 – Defective Pixel Map Cursor Enable Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x38	Defective Pixel Map Cursor Enable Command ID.
3	0x00	Parameters length.
4, 5	unsigned integer	0 = cursor disable 1 = cursor enable
6	checksum	Frame check sequence.

Response Format:

Table 121 – Defective Pixel Map Cursor Enable Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response
3	0x02	Parameters length.
4, 5	0x0038	Defective Pixel Map Cursor Enable Command ID.
6	checksum	Frame check sequence.

3.6.2 Defective Pixel Map Cursor Position Set – 0x3A

Description: Sets the location of the defective pixel cursor.

Command Format:

Table 122 – Defective Pixel Map Cursor Position Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x3A	Defective Pixel Map Cursor Position Set
3	0x04	Parameters length.
4, 5	unsigned integer 0 to (FPA rows – 1)	Cursor row index. Valid values are 0 to 479.
6, 7	unsigned integer 0 to (FPA cols – 1)	Cursor column index. Valid values are 0 to 639.
8	checksum	Frame check sequence.

Response Format:

Table 123 – Defective Pixel Map Cursor Position Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response
3	0x02	Parameters length.
4, 5	0x003A	Defective Pixel Map Cursor Position Set Command ID.
6	checksum	Frame check sequence.

3.6.3 Defective Pixel Map Cursor Value Set – 0x37

Description: Selects the value of the defective pixel cursor.

Command Format:

Table 124 – Defective Pixel Map Cursor Value Set Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x37	Defective Pixel Map Cursor Value Set Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer 0 to 0x3FFF	Cursor value. 0= black cursor 0x3FFF = white cursor Cursor values greater than 0x3FFF will result in a white cursor.
6	checksum	Frame check sequence.

Response Format:

Table 125 – Defective Pixel Map Cursor Value Set Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK response
3	0x02	Parameters length.
4, 5	0x0037	Defective Pixel Map Cursor Value Set Command ID.
6	checksum	Frame check sequence.

3.6.4 Defective Pixel Map Pixel Add – 0x3B

Description: Add a single pixel to the defective pixel map.

Command Format:

Table 126 – Defective Pixel Map Pixel Add Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x3B	Non-Volatile Parameters Set Default Command ID.
3	0x04	Parameters length.
4, 5	unsigned integer 0 to (FPA rows – 1)	Cursor row index. Valid values are 0 to 479.
6, 7	unsigned integer 0 to (FPA cols – 1)	Cursor column index. Valid values are 0 to 639.
8	checksum	Frame check sequence.

Response Format:

Table 127 – Defective Pixel Map Pixel Add Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x003B	Non-Volatile Parameters Set Default Command ID.
6	checksum	Frame check sequence.

3.6.5 Defective Pixel Map Row Add – 0x34

Description: This command adds a row to the defect map. All pixels on the row will be marked as defective.

Command Format:

Table 128 – Defective Pixel Map Row Add Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x34	Defective Pixel Map Row Add Command ID.
3	0x02	Parameters length.
4, 5	unsigned integer 0 to (FPA rows – 1)	Cursor row index. Valid values are 0 to 479
6	checksum	Frame check sequence.

Response Format:

Table 129 – Defective Pixel Map Row Add Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0034	Defective Pixel Map Row Add Command ID.
6	checksum	Frame check sequence.

3.6.6 Defective Pixel Map Column Add – 0x36

Description: Add a column to the defect map. All pixels in the column will be marked as defective.

Command Format:

Table 130 – Defective Pixel Map Column Add Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x36	Defective Pixel Map Column Add Command ID.
3	0x02	Parameters length.
4, 5	unsigned integer 0 to (FPA cols – 1)	Cursor column index. Valid values are 0 to 639.
6	checksum	Frame check sequence.

Response Format:

Table 131 – Defective Pixel Map Column Add Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0036	Defective Pixel Map Column Add Command ID.
6	checksum	Frame check sequence.

3.6.7 Defective Pixel Map Remove Item – 0x35

Description: Removes a dead pixel, row, or column from the defective pixel map.

Command Format:

Table 132 – Defective Pixel Map Remove Item Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x3B	Defective Pixel Map Remove Item Command ID.
3	0x06	Parameters length.
4, 5	unsigned integer See table below.	Remove item operation ID.
6, 7	unsigned integer 0 to (FPA rows – 1)	Cursor row index. Valid values are 0 to 479.
8, 9	unsigned integer 0 to (FPA cols – 1)	Cursor column index. Valid values are 0 to 639.
10	checksum	Frame check sequence.

Response Format:

Table 133 – Defective Pixel Map Remove Item Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x003B	Defective Pixel Map Remove Item Command ID.
6	checksum	Frame check sequence.

Table 134 – Remove Item Operation IDs

Byte	Value	Description
0	Remove pixel	Pixel at row index and column index will be removed from the defect map.
1	Remove row	All pixels at row index will be removed from the defect map. The column index is ignored for this operation.
2	Remove column	All pixels at the column index will be removed from the defect map. The row index is ignored for this operation.

3.6.8 Defective Pixel Map Remove All – 0x3C

Description: Remove all pixels from the defective pixel map.

Command Format:

Table 135 – Defective Pixel Map Remove All Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x3C	Defective Pixel Map Remove All Command ID.
3	0x00	Parameters length.
4	checksum	Frame check sequence.

Response Format:

Table 136 – Defective Pixel Map Remove All Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x003C	Defective Pixel Map Remove All Command ID.
6	checksum	Frame check sequence.

3.6.9 Defective Pixel Map Flash Burn – 0xFB

Description: Permanently store all marked dead pixels into Flash Memory.

Command Format:

Table 137 – Defective Pixel Map Flash Burn Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xFB	Defective Pixel Map Flash Burn Command ID.
3	0x04	Parameters length.
4, 5	0xXX	Defective Pixel Map Flash Sector
6, 7	0x00	Write
8	checksum	Frame check sequence.

Response Format:

Table 138 – Defective Pixel Map Flash Burn Response Format

Byte	Value	Description
1	0x01	Start of message.

2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00FB	Defective Pixel Map Remove All Command ID.
6	checksum	Frame check sequence.

3.7 TROUBLESHOOTING COMMANDS

The troubleshooting commands are used for troubleshooting hardware and software features of the TIM.

3.7.1 Serial Echo – 0x06

Description: Test communications to and from the TIM. The TIM echoes the command message and parameters and generates an ACK message.

Command Format:

Table 139 – Serial Echo Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x06	Serial Echo Command ID.
3	N	Parameters length.
4 to (N+3)	Null-terminated string.	String to be echoed. String length is arbitrary but total message size must be less than MTU size.
(N+4)	checksum	Frame check sequence.

Response Format:

This command results in two response messages. The first response message is a TXT message containing the echoed string. The second response message is an ACK message.

Table 140 – Serial Echo TXT Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x06	Echo command
3	N	Parameters length.
4 to (N+3)	Null-terminated string.	Echoed string.
(N+4)	checksum	Frame check sequence.

Table 141 – Serial Echo ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0006	Serial Echo Command ID.
6	checksum	Frame check sequence.

3.7.2 Tcomp Disable – 0x18

Description: Disables or enables TIM temperature compensation (Tcomp).



WARNING

Disabling temperature compensation should only be used in a debug environment with test patterns. Disabling temperature compensation will result in severely degraded performance.

Command Format:

Table 142 – Tcomp Disable Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0x18	Tcomp Disable Command ID.
3	0x02	Parameters length.
4 to 5	0 = enable 1 = disable.	Disable/enable. Note value of 1 disables Tcomp.
6	checksum	Frame check sequence.

Response Format:

This command results in an ACK message.

Table 143 – Tcomp Disable ACK Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x0018	Tcomp Disable Command ID.

6	checksum	Frame check sequence.
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3.7.3 Test Pattern Select – 0xF4

Description: Enables and selects a video test pattern. Selecting test pattern <0x0000> disables the test pattern generator. This test pattern replaces the input video stream from the FPA and facilitates testing of downstream processing blocks.

This requires a sequence of commands. The current mode of operation can also affect how the test patterns look and the actual pixel values on the digital interfaces. Using a pre AGC video tap (14 bit data) will allow for pixel data validation.

Also, note if automatic calibration has not been disabled or a range change occurs while a test pattern is selected the test pattern will be corrupted.

The to avoid these issues command sequence should be as follows:

1. 0x01 0x18 0x02 0x00 0x01 0xE4, to disable Tcomp.
2. 0x01 0xAC 0x00 0x53, to disable Autocal.
3. 0x01 0xF4 0x02 0x80 0x0 0x89, to enable horizontal ramp (for example) test pattern.
4. (optional) 0x01 0xD7 0x02 0x00 0x04, if 14-bit test patterns are desired. Otherwise, test pattern will be 8-bit.

When test pattern is no longer used, it is best to power cycle the camera to restore to normal operation.

Command Format:

Table 144 – Test Pattern Select Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xF4	Test Pattern Select Command ID.
3	0x02	Parameters length.
4, 5	unsigned integer See table below.	Test Pattern ID.
6	checksum	Frame check sequence.

Table 145 – Test Pattern IDs

Test Pattern ID	Description	Test Pattern ID	Description	Test Pattern ID	Description
0x0000	Off	0x8003	Horizontal Bars	0x8007	Gray
0x8000	Horizontal Ramp	0x8004	Vertical Bars	0x8008	NUC 14-bit
0x8001	Vertical Ramp	0x8005	Black	0x8009	NUC 64 shade
0x8002	Diagonal Ramp	0x8006	White		

Response Format:

Table 146 – Test Pattern Select Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00F4	Test Pattern Select Command ID.
6	checksum	Frame check sequence.

3.7.4 RS170 Test Pattern Enable – 0xD8

Description: Enables RS170 test pattern. The test pattern is a full screen of 16 vertical bars that vary from black on the left to white on the right. When this test pattern is enabled, it does not affect other processing on the TIM. The RS170 test pattern overrides normal RS170 output. RS170 output must be enabled or test pattern will not be output.

Command Format:

Table 147 – RS170 Test Pattern Enable Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xD8	RS170 Test Pattern Enable Command ID.
3	0x02	Parameters length.
4, 5	Unsigned integer	0 disables RS170 test pattern. non-zero enables RS170 test pattern.
6	checksum	Frame check sequence.

Response Format:

Table 148 – RS170 Test Pattern Enable Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00D8	RS170 Test Pattern Enable Command ID.
6	checksum	Frame check sequence.

3.7.5 Verbose Mode Toggle – 0xFF

This command toggles the TIM's verbose mode. In verbose mode, the TIM generates additional TXT messages during operation as an aid to testing.

Description: Toggles the display of verbose messaging.

Command Format:

Table 149 – Verbose Mode Toggle Command Format

Byte	Value	Description
1	0x01	Start of message.
2	0xFF	Verbose Mode Toggle Command ID.
3	0x00	Parameters length.
6	checksum	Frame check sequence.

Table 150 – Verbose Mode Toggle Command Format (Option 2)

Byte	Value	Description
1	0x01	Start of message.
2	0xFF	Verbose Mode Toggle Command ID.
3	0x02	Parameters length.
4, 5	0x0000 0x0001	0 disables verbose mode. 1 enables verbose mode.
6	checksum	Frame check sequence.

Response Format:

Table 151 – Verbose Mode Toggle Response Format

Byte	Value	Description
1	0x01	Start of message.
2	0x02	ACK Response
3	0x02	Parameters length.
4, 5	0x00FF	Verbose Mode Toggle Command ID.
6	checksum	Frame check sequence.

4 COMMAND QUICK-REFERENCE

In this section a list of commands is provided to aid you in customizing your scripts and camera control.

Table 152 – Message Quick Reference

Cmd (Hex)	Description	RTL Rel version required (needs to be paired with compatible CPU(Rel) version)
0x06	Echo Test	
0x07	System Version Get	
0x12	Automatic Calibration Period Set	
0x13	Automatic Calibration Period Get	
0x18	Tcomp Disable	
0x1E	ICE Strength	01.00.4471 or newer
0x1F	ICE High Frequency Threshold Set	01.00.4189 or newer (Deprecated)
0x22	ICE Mode Min Max	01.00.3532 or newer (Deprecated)
0x23	ICE Mode Enable	01.00.3532 or newer
0x25	AutoCal Pending Activity Query	
0x26	AutoCal Activity Control (Enable/Disable)	
0x27	Field Calibrate	
0x28	AGC Black-Hot Enable	
0x29	AGC White-Hot Enable	
0x2A	AGC Mode Set	
0x32	AGC Manual Gain Set	
0x33	AGC Manual Level Set	
0x34	Defective Pixel Map Row Add	
0x35	Defective Pixel Map Remove Item	
0x36	Defective Pixel Map Column Add	
0x37	Defective Pixel Map Cursor Value Set	
0x38	Defective Pixel Map Cursor Enable	
0x3A	Defective Pixel Map Cursor Position Set	
0x3B	Defective Pixel Map Pixel Add	

Cmd (Hex)	Description	RTL Rel version required (needs to be paired with compatible CPU(Rel) version)
0x3C	Defective Pixel Map Remove All	
0x41	Data Transfer Download Packet	
0x43	Data Transfer Abort	
0x46	Data Transfer Download Retry	
0x47	Data Transfer Download Complete	
0x72	Data Transfer Upload Packet	
0x73	Data Transfer Download Setup	
0x74	Data Transfer Upload Setup	
0x81	Field Calibrate - Shutter Disable	
0x82	AGC Gain Bias Set	
0x83	AGC Level Bias Set	
0x84	AGC Region of Interest	
0xA0	AGC Options Set	
0xA4	Zoom Magnification Set	
0xA5	Zoom Pan Set	
0xA6	Zoom Store Current Settings	01.00.3532 or newer
0xAC	Automatic Calibration Toggle	
0xB0	Non-Volatile Parameters Set	
0xB3	Non-Volatile Parameters Set Default	
0xB5	Non-Volatile Parameters Get	
0xCA	Customer Non-Volatile Read	
0xCB	Customer Non-Volatile Write	
0xCC	Enable Colorization	01.00.3532 or newer
0xCD	8-Bit Colorization Selection	01.00.3532 or newer
0xCF	Video Orientation Select	
0xD1	AGC Gain Limit Set	
0xD2	AGC Gain Flatten Offset Set	

Cmd (Hex)	Description	RTL Rel version required (needs to be paired with compatible CPU(Rel) version)
0xD7	Digital Video Source Select	
0xD8	RS170 Test Pattern Enable	
0xF1	Baud Rate Set	
0xF2	System Status Get	
0xF4	Test Pattern Select	
0xFB	Defective Pixel Map Flash Burn	
0xFF	Verbose Mode Toggle	