Tau™ 2 / Quark™ Software Interface Description Document (IDD)

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1.1 Revision History

Rev. #	Date	Comments
100	11/07/2011	Initial Release.
110	8/30/2012	Updated for Tau 2.1 release. Specific changes include: • Cmd ID 0x0F: Added description of new bit in the command argument which can be used to enable/disable or freeze/unfreeze analog video without the zoom bits being interpreted as valid. • Cmd ID 0x20: Added housing temp, accelerometer data, and overtemp status option to READ_SENSOR. • Cmd ID 0x2F: Removed statement that symbol resolution is 640x512 for all configurations. • Cmd ID 0x32: Added EZOOM_CONTROL command • Cmd ID 0x43: Modified GET_SPOT_METER_DATA command to include optional get/set of spot-meter coordinates and to get more detailed spot-meter data (not available on all configurations). • Cmd ID 0x4C: Eliminated get/set of 2X, 4X, and 8X ROI since these are no longer valid in Tau 2.1. Changed range to ±50%. • Cmd ID 0x4D: Added SHUTTER_TEMP command • Cmd ID 0x70: Added PAN_AND_TILT command. • Cmd ID 0x82: Added new 8-bit bitmap type to TRANSFER_FRAME. • Cmd ID 0xD6: Added new 8-bit bitmap type to GET_MEMORY_ADDRESS • Cmd ID 0xE5: Added new LENS_RESPONSE_PARAMS command • 3.3: Added EZOOM_CONTROL and PAN_AND_TILT to the list of commands affecting analog video / BT.656 • 3.5: Added several parameters. to the list of parameters affected by SET_DEFAULTS and RESTORE_FACTORY_DEFAULTS. Changed factory-default ROI coordinates. Other corrections relative to Rev. 100 of this document: • 3.1.2: Fixed an error in which it was stated the core replies to the BAUD_RATE command at the previous rate. Core actually replies to the command at the newly specified baud rate. • 3.2.2: Added table of non-blocking commands. • Cmd ID 0x2F: Corrected argument definitions for SYMBOL_ CONTROL. (Arguments for “freeze” and “unfreeze” options were erroneously swapped.) • Cmd ID 0x72: Corrected argument definitions for VIDEO_ STANDARD.
120	05/20/2013	Updated for Tau 2.4 release. Specific changes include: • Cmd ID 0x12: Added new DIGITAL_OUTPUT_MODE commands • Cmd ID 0x70: Added a note about new capability to remove pan/tilt limit • Cmd ID 0x8E: Added TLIN_COMMANDS command. • Cmd ID 0xB1: Added valid arguments for advanced radiometry • Cmd ID 0xE5: Added new LENS_RESPONSE parameters • 3.3 and 3.5: Added new TLinear commands

		Other corrections relative to Rev. 110 of this document: • 3.2.1 Status Byte: Added a note about CAM_TIMEOUT_ERROR being returned from a dll. • Cmd ID 0x43: Corrected the byte count for Resp • Cmd ID 0x67: Removed reference cmd

1.2 Scope

Tau ™ and Quark are both miniature infrared imaging cores from FLIR Systems®, offered in various configurations. This Interface Description Document (IDD) specifically applies to the Tau 2 configuration of Tau and all configurations of Quark. It defines software interface requirements and commands for both products. Except where noted, all requirements / commands apply to both products, hereafter referred to generically as "the core".

Generally speaking, the Tau 2 serial-communication interface is backwards compatible with Tau 1.X. (That is, an external device designed to communicate with a Tau 1.X core will also be capable of communicating with a Tau 2 core.) However, Tau 2 provides more capabilities and therefore a larger command set. Furthermore both Tau 2 and Quark are intended to be field-upgradeable with feature improvements over time. Consequently this software IDD will be updated to reflect the new commands associated with each upgrade. These are summarized in Table 1.

Note: Even though Tau 2 and Tau 1.X share a compatible serial-comm. interface, they are different products with different hardware. It is not possible to upgrade a Tau 1.X core with Tau 2 code, and attempting to do so will cause device failure. Similarly, a Tau 2 cannot be upgraded with Quark code or vice versa.

Table 1: Tau 2 / Quark 1 Release Summary

Release Version	Release Date	New Features / Differences
Tau 2.0 / Quark 1.0	Oct. 2011	Differences shown below are relative to Tau 1.X. • Auto-polarity detection (see 3.1.1) • New baud rate options (see 3.1.2, and command ID# 0x07 in Table 2-4) • Modification of the DIGITAL_OUTPUT_MODE command (0x12) to support setting CMOS and LVDS bit-width independently. • Modification of the ISOTHERM_THRESHOLDS command (0x23) to support 3-color isotherm. (Tau 1.5 provided a 2-color isotherm only.) • Addition of a SPLASH_CONTROL command (0x31) that provides adjustment of splash-screen timing. • Removal of the PAN_AND_TILT command (0x70). In Tau 2 / Quark, zoom is always relative to the center of the array. • Modification of the VIDEO_STANDARD command (0x72) to include averager-disabled options.
Tau 2.1	Aug. 2012	Differences shown below are relative to Tau 2.0. • New continuous zoom capability. Affected commands: o New bit to VIDEO_MODE (0x0F) allowing fixed zoom bits to be ignored. This enables the command to be used for enabling or freezing analog video without affecting zoom. o New EZOOM_CONTROL command (0x32) o Change to AGC_ROI (0x4C) o New PAN_AND_TILT (0x70) for changing the location of the zoom window within the field of view

		• New ability to capture 8-bit snapshots. Affected commands:
		  ○ New argument in TRANSFER_FRAME (0x82)
		  ○ New arguments in GET_MEMORY_ADDRESS (0xD6)
		• New spot-meter capability (not available on all configurations). Affects GET_SPOT_METER_DATA (0x43)
		• Addition of housing temp, accelerometer data, and overtemp status in the READ_SENSOR command (see command ID 0x20)

Tau 2.4	May 2013	Differences shown below are relative to Tau 2.1. (Any text shown in blue font in this document represents a difference relative to Tau 2.1.) • Continuous zoom capability for 8-bit digital output (SW selectable). New argument in DIGITAL_OUTPUT_MODE (0x12) • Colorization capability for 8-bit digital output (SW selectable). New argument in DIGITAL_OUTPUT_MODE (0x12) • New TLinear capability (not available on all configurations). New command TLIN_COMMANDS (0x8E) • New external scene parameters for improved radiometric accuracy. New arguments LENS_RESPONSE_PARAMS (0xE5)

2 References

The following documents form a part of this specification to the extent specified herein.

2.1 FLIR Website / Contact Information

In multiple locations throughout this document, FLIR's Tau / Quark website is referenced as a source of additional information. This websites can be accessed via the following URL:

www.flir.com/cvs/cores/uncooled/products/tau/

http://www.flir.com/cvs/cores/uncooled/products/quark/

Additionally, FLIR's Applications Engineering Department is referenced as a resource for obtaining additional help or information. The department can be accessed via the following phone number: +1-805-964-9797 (or toll-free within the United States at 888-747-FLIR (888-747-3547).) Email requests can be addressed to SBA-cores@flir.com.

2.2 FLIR Systems Documents

Ref. 1	102-PS241-40	Quark Product Specification
Ref. 2	102-PS241-41	Quark Electrical Interface Description Document
Ref. 3	102-PS242-40	Tau 2 Product Specification
Ref. 4	102-PS242-41	Tau 2 Electrical Interface Description Document

2.3 External Documents

Ref. 5	ANSI/TIA/EIA-232 (formerly RS232)	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

2.4 Acronyms / Abbreviations

AGC	Automatic Gain Control
CCITT	Commite' Consultatif International de Telegraphique et Telephonique. (International consultative committee on telecommunications and Telegraphy)
CRC	Cyclic Redundancy Check
DDE	Digital Detail Enhancement
FFC	Flat Field Correction
FOV	Field of View
FPA	Focal Plane Array
FW	Firmware
IDD	Interface Description Drawing / Document
LSB	Least Significant Bit
LUT	Look-Up Table
LVDS	Low-Voltage Differential Signaling
MSB	Most Significant Bit
NTSC	National Television System Committee
PAL	Phase Alternating Line
ROI	Region of Interest
SW	Software
TBD	To Be Determined
XP	eXPansion
WFOV	Wide Field of View

3 Serial Communications Protocol

The serial communication channel is a two-node, master-slave interface between an external device and the core. The external device is considered the "master" in that it initiates all communications. The core is a "slave" that generates a reply to each received message. For the purposes of this document "incoming" or "received" messages refer to those from the master device to the core, and "reply" messages refer to those from the core to the master device.

3.1 Port Settings

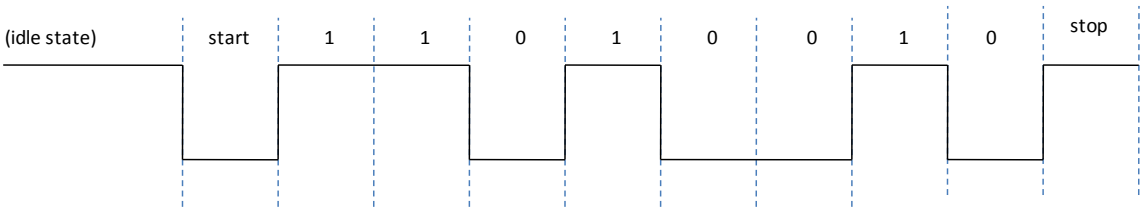
Table 3-1 defines the serial port settings of the serial communication interface.

Table 3-1 Serial Port Settings

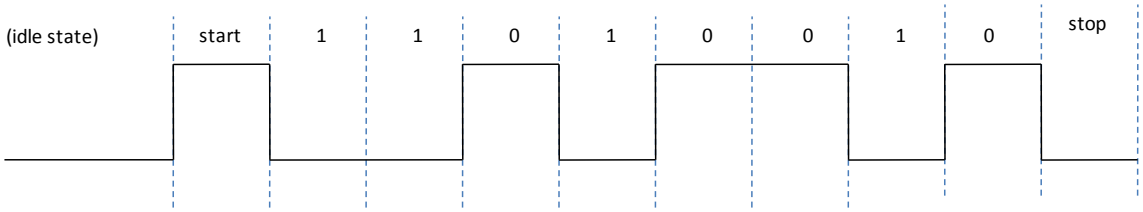
Parameter	Value
Signaling polarity	Auto-detected. See 3.1.1
Baud rate	Configurable. See 3.1.2
Data bits	8
Parity	None
Start bits	1
Stop bits	1
Flow control	None
Bit order	Least significant first (after start bit)

3.1.1 Signaling Polarity

The polarity of incoming packets on the RS232 channel is automatically detected by the core. That is, the core will automatically detect whether the host is transmitting standard or inverted logic and will reply via the same. Anytime the signal level of core's RX line (i.e., the host's TX line) remains static for an entire frame period, the core assumes that the current level is the quiescent state. For example, if the quiescent state is at 3.3V as depicted in Figure 1a, the core assumes standard logic. If the quiescent state is at ground as depicted in Figure 1b, the core assumes inverted logic. At power-on, the core assumes inverted logic by default until a complete frame period elapses with no traffic on its RX line. Note that auto-polarity detection is always active and therefore signal polarity can be switched dynamically in the middle of a power cycle (though this is not expected to occur in practice).



(a) Standard Logic



(b) Inverted Logic

Figure 1: Example of Standard and Inverted Comm. Traffic

3.1.2 Baud Rate

The baud rate of the serial comm. channel is configurable to any of the following:

1. Auto-baud (as described below)
2. 9.6k
3. 19.2k
4. 28.8k
5. 57.6k
6. 115.2k
7. 460.8k
8. 921.6k

Note: Baud rate tolerance to incoming messages is +/- 3%. Outgoing messages are to within +/-1%.

The baud rate is configured via the BAUD_RATE command (0x07) and capable of being stored as a power-on default via the SET_DEFAULTS command (0x01). The BAUD_RATE command must be sent at the current baud rate, and the core replies to the command at the specified rate. All subsequent commands must then be sent at the newly specified baud rate. For example, if the power-on default for a particular core is 460.8k and a new baud rate of 28.8k is desired, the BAUD_RATE command specifying a change to 28.8k must be sent at 460.8k. The core will reply with an acknowledgement at 28.8k. All future commands on the current power cycle must then be sent at 28.8k baud. At the next power up, the core will return to its power-on default, 460.8k, unless 28.8k was established as the new power-on default by having sent the SET_DEFAULTS command after sending the BAUD_RATE command.

Note: If the host is ignorant of the current baud rate setting, it must attempt communication at each baud rate until receiving a valid response. Caution should be exercised when storing a new baud rate as power-on default unless the host is capable of cycling through all possible baud rates.

When auto-baud is the current baud-rate setting, the core attempts to detect baud rate from the first message received via the following process:

- The elapsed time between the first 6 edges is measured on the RX line (from rise to fall or fall to rise). If the shortest of the 5 elapsed-time periods is between 0.860 usec and 1.302 usec (that is, $(921.6\ \text{kHz})^{-1}$ $\pm$20%), the core sets its baud rate to 921.6k. If the shortest period is between 13.889 usec and 20.833 usec (that is, $(57.6\ \text{kHz})^{-1}$ $\pm$20%), the core sets its baud rate to 57.6k. Otherwise the auto-detection process starts over again. Figure 2 illustrates the process for a transmitted byte 0x6E, which includes 6 edges and happens to be the first byte of every valid command to the core (see 3.2). Either the period marked #3 or that marked #5 in the figure will be identified as the shortest transition and therefore used to select baud rate.
    - *Note 1: Glitches on the receive line might possibly result in an erroneous detection.*
    - *Note 2: The receive logic defaults to 57.6k (i.e., data are sampled at 57.6k beginning with the first start bit). If data is sent at 921.6k, it will be incorrectly sampled until the auto-baud detection process has locked onto the correct baud rate. Consequently, a core in auto-baud will only generate a valid reply to the first message sent by the host if that message is sent at 57.6k. A message sent at 921.6k will establish the faster baud rate but will not generate a valid reply. (The second message sent at 921.6k will be the first that generates a valid reply.) For that reason, it is recommended to send a No Op command (0x00) as the first message when operating in auto-baud mode.*
    - *Note 3: The auto-baud detection only occurs once per power cycle; all communications thereafter must be at the same rate.*

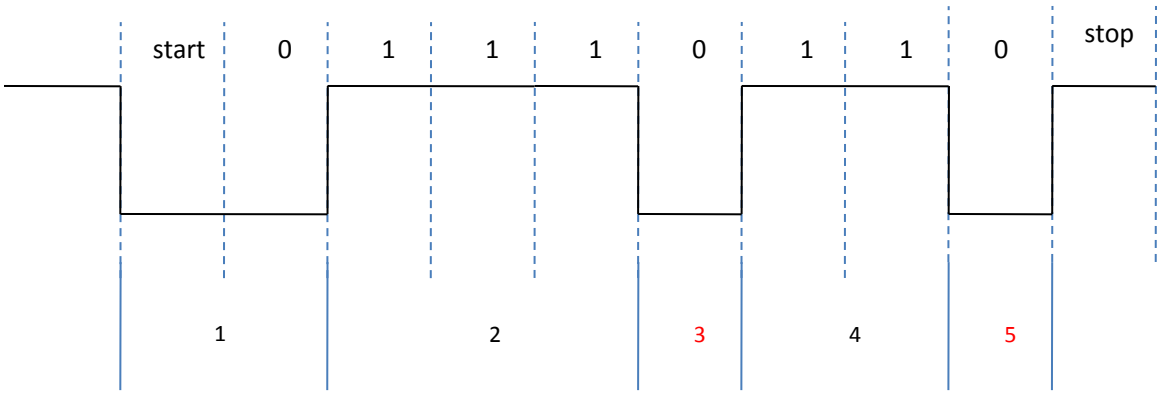


Figure 2: Illustration of Edges Used in Auto-Baud Detection Algorithm

3.2 Packet Protocol

All incoming and reply messages shall adhere to the packet protocol defined in Table 3-2 and the subparagraphs that follow.

Table 3-2 Packet Protocol

Byte #	Upper Byte	Comments
1	Process Code	Set to 0x6E on all valid incoming and reply messages
2	Status	See 3.2.1
3	Reserved	
4	Function	See 3.2.2
5	Byte Count (MSB)	See 3.2.3
6	Byte Count (LSB)	
7	CRC1 (MSB)	See 3.2.4
8	CRC1 (LSB)	
N	Argument	See 3.2.5
N+1	CRC2 (MSB)	See 3.2.4
N+2	CRC2 (LSB)	

3.2.1 Status Byte

The second byte of each incoming packet is ignored. For all reply messages, the core sets the second byte as shown in Table 3-3 to indicate status of the previous incoming message packet. The decoding of the incoming message is as follows:

1) The byte-count bytes are read to determine the expected length of the packet. If the incoming packet duration exceeds a timeout period (nominally 100 msec), CAM_TIMEOUT_ERROR is reported (status byte = 0x07).
   Note: Camera SW does not respond with a 0x07 timeout error, but the UL3-RS232.dll used in many applications does provide this message status response.
2) Once the full packet has been received, the CRC bytes are checked first (see 3.2.4). If either is incorrect, CAM_CHECKSUM_ERROR is reported (status byte = 0x04).
3) The process-code byte is then checked; if it is not equal to 0x6E, CAM_UNDEFINED_PROCESS_ERROR is returned (status byte = 0x05).
4) The function code is then checked, and if it is invalid (i.e., not one of the codes shown in Table 3-5), CAM_UNDEFINED_FUNCTION_ERROR is returned (status byte = 0x06). CAM_FEATURE_NOT_ENABLED (status byte = 0x0A) is also a possible return if the function code is not supported by the particular configuration (e.g., the command is supported in some configurations of the core, just not the particular configuration receiving the command).
5) The packet length is then checked. If the length is invalid for the function code, CAM_BYTE_COUNT_ERROR is returned (status byte = 0x09).
6) For some function codes, the range of the argument is limited. In those cases, the argument is checked, and CAM_RANGE_ERROR is returned if it is invalid (status byte = 0x03).
   Note: Any reply packet reporting an error will have no data bytes (i.e., byte count = 0).

Table 3-3 Status Byte Definition

Status Byte Value (hex)	Definition	Description
0x00	CAM_OK	Message received
0x03	CAM _RANGE_ERROR	Argument out of range
0x04	CAM _CHECKSUM_ERROR	Header or message-body checksum error
0x05	CAM _UNDEFINED_PROCESS_ERROR	Unknown process code
0x06	CAM _UNDEFINED_FUNCTION_ERROR	Unknown function code
0x07	CAM _TIMEOUT_ERROR	Timeout executing serial command
0x09	CAM _BYTE_COUNT_ERROR	Byte count incorrect for the function code
0x0A	CAM _FEATURE_NOT_ENABLED	Function code not enabled in the current configuration

3.2.2 Function Byte

The function-code byte is used to specify the function of an incoming message. For all reply messages, the camera will echo back the function-code byte. A list of all valid Tau 2 / Quark commands is shown in Table 3-5. For most of these commands, the core replies *after* it has executed the specified function. Such commands are referred to as "synchronous" or "blocking". For a few select commands, the core replies to acknowledge receipt of the message *before* execution of the command is complete. For example, the core replies immediately to the DO_FFC command rather than delaying the response until the FFC operation is complete. Such commands are referred to as "asynchronous" or "non-blocking", and all are noted explicitly in Table 3-5 (and additionally listed in Table 3-4 below). Some non-blocking commands such as those which result in writing the core's non-volatile memory have an associated status message that can be used to poll the core for progress. This information is also explicitly noted in Table 3-5.

Table 3-4 List of Non-blocking Commands

ID	Function Code	Command
1	0x01	SET_DEFAULTS
12	0x0C	DO_FFC
37	0x25	TEST_PATTERN
47	0x2F	SYMBOL_CONTROL
121	0x79	SHUTTER_PROFILE
130	0x82	TRANSFER_FRAME
198	0xC6	WRITE_NVFFC_TABLE

3.2.3 Byte Count Bytes

The byte-count bytes are used to specify the number of argument bytes in the packet (not the total number of bytes in the packet). The byte count will typically be an even number, with range between 0 and 0x0106 (262 decimal). See Table 3-5 for the expected byte count associated with each function-code byte. Note that the byte-count of an incoming message is not necessarily equal to the byte count of the reply message. Note also in Table 3-5 that many function bytes are overloaded (i.e., have different behavior depending upon byte-count). For example, if the BAUD_RATE command (0x07) is sent with a byte count of 0, the core replies with the current baud rate without modifying it. If sent with a byte count of 2, the core changes the baud rate to the value specified by the 2-byte argument. (This type of command is referred to as a set/get since it can be used for either purpose.)

3.2.4 CRC Bytes

On all incoming and outgoing messages, two cyclical redundancy checks (CRCs) are calculated using CCITT-16 initialized to 0. (Polynomial = $x^{16} + x^{12} + x^5 + 1$.) CRC1 is calculated using only the first 6 bytes of the packet. CRC2 is calculated using all previous bytes in the packet (i.e. bytes 0 through N). Below is an example showing a CRC calculation for the single byte 0x6E.

Data = 0x6E = 01101110 (binary); Polynomial = 10001000000100001 (binary)

```
  0110111000000000000000000      [data is right-padded with 16 zeros]
⊕ 010001000000100001
---------------------------------------
  001010100000100001000000
⊕ 001000100000100001
---------------------------------------
  000010000000110001100000
⊕ 000100010000000100001
---------------------------------------
  000010000000110001100000
⊕ 000010001000000100001
---------------------------------------
  000000001000110101101000
⊕ 000001000100000100001
---------------------------------------
  000000001000110101101000
⊕ 000000100010000000100001
---------------------------------------
  000000001000110101101000
⊕ 000000010001000000100001
---------------------------------------
  000000001000110101101000   = 0x8D68
```

3.2.5 Argument Bytes

The argument bytes (also called data bytes) are used to encode the argument of a message packet. The number of argument bytes is typically an even number. See Table 3-5 for the argument definition for each message. Two's-complement numbering is used for all signed values. Big-endian ordering is employed:

Byte 0, Byte 1, Byte 2, etc.

3.2.6 Serial Command List

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0	0x00	NO_OP	No operation	Cmd:0 Reply:0	None	The typical use of this command is to verify proper communication via a valid reply from the core.
1	0x01	SET_DEFAULTS	Sets all current settings as power-on defaults This command is non-blocking (see 3.2.2). The MEMORY_STATUS command (ID #196) is the associated status command.	Cmd:0 Reply:0	None	See Table 3-6 for a list of all affected parameters.
2	0x02	CAMERA_RESET	Commands a camera reset / reboot	Cmd:0 Reply:0	None	
3	0x03	RESTORE_ FACTORY_ DEFAULTS	Reverts settings to factory defaults.	Cmd:0 Reply:0	None	See Table 3-6 for a list of all affected parameters. This command “undoes” any parameter changes (including those stored as power-on defaults), restoring all to factory-default values. This command must be followed by the SET_DEFAULTS command (0x01) to restore the factory settings as power-on defaults.
4	0x04	SERIAL_NUMBER	Gets the serial number of the camera and sensor	Cmd: 0 Reply: 8	None Bytes 0-3: Camera serial number Bytes 4-7: Sensor serial number	
5	0x05	GET_REVISION	Gets the firmware / software version	Cmd: 0 Reply: 8	None Bytes 0-1: SW major version Bytes 2-3: SW minor version Bytes 4-5: FW major version Bytes 6-7: FW minor version	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
7	0x07	BAUD_RATE	Gets or sets the baud rate of the serial comm. channel	Get Cmd: 0 (Reply: 2)	None	See 3.1.2 for further explanation.
				Set Cmd: 2 & Reply: 2	0x0000: Auto baud 0x0001: 9600 baud 0x0002: 19200 baud 0x0003: 28800 baud 0x0004: 57600 baud 0x0005: 115200 baud 0x0006: 460800 baud 0x0007: 921600 baud	
10	0x0A	GAIN_MODE	Gets or sets the dynamic-range-control mode	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.2.2 of Ref. 1 / Ref. 3 for definition of each mode.
				Set Cmd:2 & Reply: 2	0x0000 = Automatic 0x0001 = Low Gain Only 0x0002 = High Gain Only 0x0003 = Manual	
11	0x0B	FFC_MODE_ SELECT	Gets or sets the Flat Field Correction (FFC) mode	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.2.1 of Ref. 1 / Ref. 3 for definition of each mode.
				Set Cmd:2 & Reply: 2	0x0000 = Manual 0x0001 = Automatic 0x0002 = External	
12	0x0C	DO_FFC	Commands FFC A “short” or “long” FFC can be optionally specified. If sent with no argument, a short FFC is executed. This command is non-blocking (see 3.2.2). There is no associated status command.	Cmd:0 Reply:0	None	See para. 3.3.2.1 of Ref. 1 / Ref. 3 for explanation of short FFC and long FFC.
				Cmd: 2	0x0000 = short FFC 0x0001 = long FFC	
				& Reply: 2	0xFFFF	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
13	0x0D	FFC_PERIOD	Gets or sets the interval (in frames) between automatic FFC; different values are specified for each gain state	Get Cmd: 0 (Reply: 4)	None	Range: 0 to 30,000 (frames) An argument value of 0 signals that elapsed time will not be used to trigger FFC. See para. 3.3.2.1 of Ref. 1 / Ref. 3 for explanation of the parameter.
				Set Cmd:2 & Reply: 2	FFC interval for current gain state	
				Set Cmd:4 & Reply: 4	Bytes 0-1: FFC interval, high gain Bytes 2-3: FFC interval, low gain	
14	0x0E	FFC_TEMP_DELTA	Gets or sets the temperature difference used to trigger automatic FFC The specified value is converted to Celsius degrees by dividing by 10 then adding 0.1. For example, a value of 100 corresponds to a delta temperature of 1.1C deg.	Get Cmd: 0 (Reply: 4)	None	Range: 0 to 1000 (0.1C to 100.1C degrees) See para. 3.3.2.1 of Ref. 1 / Ref. 3 for explanation of the parameter
				Set Cmd:2 & Reply: 2	Temp delta value for current gain state	
				Set Cmd:4 & Reply: 4	Bytes 0-1: Temp delta, high gain Bytes 2-3: Temp delta, low gain	
15	0x0F	VIDEO_MODE	Gets or sets the video signal mode, enabling analog channel to be enabled/disabled and allowing freeze frame or real-time data. Note: Bits 2, 3, and 4 are valid for selecting 1X, 2X, 4X, or 8X zoom provided that bit 9 is set to 0. When bit 9 is set to 1, bits 2-4 are ignored. Note that the on-screen icons indicating 2X, 4X, and 8X zoom are enabled using the VIDEO_MODE command. The new EZOOM_CONTROL command will not causes on-screen icons to be displayed.	Get Cmd: 0 (Reply: 2)	None	See para. 3.1.2.3 and 3.3.2.4 of Ref. 1 / Ref. 3 for definition of each mode.
				Set Cmd: 2 & Reply: 2	Video mode: bit 0: 0 = real-time 1 = freeze bit 1: 0 = analog enabled 1 = analog disabled bit 2: 0 = 2X off, 1 = 2X enabled bit 3: 0 = 4X off, 1 = 4X enabled bit 4: 0 = 8X off, 1 = 8X enabled bit 9: 0 = zoom bits valid 1 = zoom bits ignored	
16	0x10	VIDEO_PALETTE	Gets or sets the video palette	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 29 See para. 3.3.2.7 of Ref. 1 / Ref. 3 for explanation of the parameter
				Set Cmd: 2 & Reply: 2	Palette number	
17	0x11	VIDEO_ ORIENTATION	Gets or sets the video orientation	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.2.3 of Ref. 1 / Ref. 3 for definition of each mode.
				Set Cmd: 2 & Reply: 2	0x0000 = Normal 0x0001 = Invert 0x0002 = Revert 0x0003 = Invert + Revert	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
18	0x12	DIGITAL_ OUTPUT_MODE	Gets or sets the digital output channel modes, depending upon byte count and arguments value.	Get Cmd: 0 (Reply: 2)	None	See para. 3.1.2.4 of Ref. 1 / Ref. 3 for definition of the various digital output modes. Note: In Tau 1.X, it was not possible to set bit depth of the CMOS and LVDS channels independently. Both had to be set to either 8bit or 14bit mode. For Tau 2, the command has been modified to allow a different bit depth to be specified for each channel.
				Set Cmd: 2 & Reply: 2	Common disable (affects both the LVDS and XP channels) 0x0000 = enabled 0x0002 = disabled	
			Gets the XP Mode	Get Cmd: 2	Byte 0: 0x02 Byte 1: don't care	
				Reply: 2	Bytes 0-1: XP Mode 0x0000 = disabled 0x0001 = BT656 0x0002 = CMOS	
			Sets the XP Mode	Set Cmd: 2 & Reply: 2	Byte 0: 0x03 Byte 1: 0x00 = disabled 0x01 = BT656 0x02 = CMOS	
			Gets the LVDS Mode	Get Cmd: 2	Byte 0: 0x04 Byte 1: don't care	
				Reply: 2	Bytes 0-1: LVDS enable 0x0000 = disabled 0x0001 = enabled	
			Set the LVDS Mode	Set Cmd: 2 & Reply: 2	Byte 0: 0x05 Byte 1: 0x00 = disabled 0x01 = enabled	
			Sets the CMOS mode Bit Depth (8 or 14bit)	Set Cmd: 2 & Reply: 2	Byte 0: 0x06 Byte 1: 0x00 = 14bit 0x01 = 8bit	
			Sets the LVDS mode Bit Depth (8 or 14bit)	Set Cmd: 2 & Reply: 2	Byte 0: 0x07 Byte 1: 0x00 = 14bit 0x01 = 8bit	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
			Gets the CMOS mode Bit Depth (8 or 14bit)	Get Cmd: 2	Byte 0: 0x08 Byte 1: don't care	
				Reply: 2	0x0000 = 14bit 0x0001 = 8bit	
			Gets the LVDS mode Bit Depth (8 or 14bit)	Get Cmd: 2	Byte 0: 0x09 Byte 1: don't care	
				Reply: 2	0x0000 = 14bit 0x0001 = 8bit	
			Sets the Digital Color Mode for 8-bit Digital Data	Set cmd: 2 & Resp: 2	Byte 0: 0x0A Byte 1: Digital Color Enable 0x00 = Disable 0x01 = Enable	Enables/Disables colorization in the 8-bit digital path. See para. 3.3.2.7 of Ref. 3 for explanation of this feature.
			Gets the Digital Color Mode for 8-bit Digital Data	Get cmd: 2	Byte 0: 0x0B Byte 1: don't care	
				Resp:2	Bytes 0-1: Digital Color Enable 0x0000 = Disable 0x0001 = Enable	
			Sets the Digital eZoom Mode for 8-bit Digital Data	Set cmd/resp: 2	Byte 0: 0x0E Byte 1: Digital Out Select Enable 0x00 = Disable 0x01 = Enable	0=Disable, 1=Enable Note: Enables/Disables eZoom in the 8-bit digital path. See para. 3.2.1, 3.2.2, and 3.3.2.4 of Ref. 3 for explanation and details regarding this feature.
			Gets the Digital eZoom Mode for 8-bit Digital Data	Get cmd: 2	Bytes 0: 0x0F Byte 1: don't care	
				Resp:2	Bytes 0-1: Digital Out Select Enable 0x0000 = Disable 0x0001 = Enable	
			Sets Bayer Encoding Order for 8-bit Digital Data	Set cmd: 2 & Resp: 2	Byte 0: 0x14 Byte 1: Bayer Order 0x00=GR, 0x01=GB, 0x02=BG, 0x03=RG	Bayer order refers to the pattern applied starting with top-left to top-right pixel in the RGB filter. See para. 3.3.2.7 of Ref. 3 for details regarding Bayer encoding.
			Gets Bayer Encoding Order for 8-bit Digital Data	Get cmd: 2	Bytes 0-1: 0x1500	
				Resp:2	Bytes 0-1: Bayer Order 0x0000=GR, 0x0001=GB, 0x0002=BG, 0x0003=RG	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
19	0x13	AGC_TYPE	Gets or sets the AGC algorithm	Get Cmd: 0	None	See para. 3.3.2.6 of Ref. 1 / Ref. 3 for definition of each algorithm.
				Set Cmd: 2 & Reply: 2	0x0000 = plateau histogram 0x0001 = once bright 0x0002 = auto bright 0x0003 = manual 0x0004 = not defined (returns error) 0x0005 = linear AGC	
20	0x14	CONTRAST	Gets or sets the contrast value used by once-bright, auto-bright, and manual AGC algorithms	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 255 See para. 3.3.2.6.3 – 3.3.2.6.5 of Ref. 1 / Ref. 3 for explanation of this parameter. It is not applicable to all AGC algorithms.
				Set Cmd: 2 & Reply: 2	Contrast value	
21	0x15	BRIGHTNESS	Gets or sets the AGC brightness value used by the manual and auto-bright AGC algorithms	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 16383 See para. 3.3.2.6.3 and 3.3.2.6.4 of Ref. 1 / Ref. 3 for explanation of this parameter. It is not applicable to all AGC algorithms.
				Set Cmd: 2 & Reply: 2	Brightness value	
24	0x18	BRIGHTNESS_BIAS	Gets or sets the brightness bias value used by the once-bright AGC algorithm	Get Cmd: 0 (Reply: 2)	None	Range: -16384 to 16383 See para. 3.3.2.6.5 of Ref. 1 / Ref. 3 for explanation of this parameter. It is not applicable to all AGC algorithms.
				Set Cmd: 2 & Reply: 2	Brightness bias value	
30	0x1E	LENS_NUMBER	Gets or sets the lens number (which affects which correction terms are applied)	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.2.10 and 3.3.2.11 of Ref. 3 for the purpose of this command.
				Set Cmd: 2 & Reply: 2	0x0000 = lens 0 0x0001 = lens 1	
31	0x1F	SPOT_METER_ MODE	Gets or sets the spot-meter mode (Returns an error for those configurations which do not support the feature.)	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.3.1 of Ref. 3 for explanation of this mode.
				Set Cmd: 2 & Reply: 2	0x0000 = disabled (off) 0x0001 = on, Fahrenheit scale 0x0002 = on, Centigrade scale	
32	0x20	READ_SENSOR	Gets various data from the core, depending upon argument of incoming message	Cmd: 2 & Reply: 2 Reply: 2	Incoming arg. | Outgoing response 0x0000 | FPA temp in deg. C*10	See 3.3.4.3 of Ref. 1 / Ref. 3

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
					0x0001 | FPA temp in raw counts 0x0002 – 0009 | unused 0x000A | Housing temp, deg. C x 100 0x000C – 0x0010 | reserved 0x0011 | Status bits: Bit 0: Overtemp status (set to 1 when operating outside temp range) Bits 1- 15: Reserved.	
				Cmd: 2	0x000B	
				Reply: 8	Accelerometer data: Bytes 0-1: X-axis (0.01 g) Bytes 2-3: Y-axis (0.01 g) Bytes 4-5: Z-axis (0.01 g) Bytes 6-7: Reserved	
33	0x21	EXTERNAL_SYNC	Gets or sets external sync mode	Get Cmd: 0 (Reply: 2)	None	See para. 3.1.2.7 of Ref. 1 / Ref. 3 for definition of each mode.
				Set Cmd: 2 & Reply: 2	0x0000 = disabled 0x0001 = slave 0x0002 = master	
34	0x22	ISOTHERM	Gets or sets the isotherm mode (on/off) (Returns an error for those configurations which do not support the feature.)	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.3.2 of Ref. 3 for explanation of the feature.
				Set Cmd: 2 & Reply: 2	0x0000 = Disabled 0x0001 = Enabled	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
35	0x23	ISOTHERM_ THRESHOLDS	Gets or sets the isotherm thresholds in percent (e.g. 97 decimal = 97%) or in deg C (e.g., 97 decimal = 97C). Bit 15 of the lower threshold is used to specify units (0 for percent, 1 for deg C). Percent is relative to a value of 160C when in high-gain mode and 600C when in low-gain mode. For example, a value of 97% equates to 155C in high-gain mode, 582C in low-gain mode. (Returns an error for those configurations which do not support the feature.)	Get Cmd: 0 (Reply: 6)	None	Percentage range: 0 – 100 Temperature range -40 to 1000 ºC Thresholds must be in proper order: (Lower <= Middle <= Upper) See para. 3.3.3.2 of Ref. 3 for definition of the thresholds.
				Set Cmd: 6 & Reply: 6	Bytes 0 – 1: lower threshold Bytes 2 – 3: middle threshold Bytes 4 – 5: upper threshold Bit 15 of the lower threshold is used to specify units (1 = deg C, 0 = %).	
37	0x25	TEST_ PATTERN	Gets or sets the test pattern mode This command is non-blocking (see 3.2.2). There is no associated status command. Note: If the command is sent more than once without disabling the test pattern in between, the core is automatically placed in manual FFC mode, manual gain mode.	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.4.2 of Ref. 3 for definition of each test pattern.
				Set Cmd: 2 & Reply: 2	0x0000 = test pattern off 0x0001 = 14-bit ascending ramp 0x0003 = big vertical 0x0004 = horizontal shade 0x0005 = factory use 0x0006 = color bars 0x0008 = ramp with steps	
38	0x26	VIDEO_COLOR_ MODE	Gets or sets the color mode (color-enabled or monochrome-only)	Get Cmd: 0 (Reply: 2)	None	See para. 3.1.2.3 of Ref. 1 / Ref. 3 for definition of these modes.
				Set Cmd: 2 & Reply: 2	0x0000 = Monochrome 0x0001 = Color enabled	
42	0x2A	GET_SPOT_METER	Returns the value of the spot meter in degrees Celsius (Returns an error for those configurations which do not support the feature.)	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.3.1 of Ref. 3 for definition of the feature.
				Reply: 2	Spot temperature value (in Celsius)	
43	0x2B	SPOT_DISPLAY	Gets or sets the spot meter display mode (Returns an error for those configurations which do not support the feature.)	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.3.1 of Ref. 3 for definition of each mode.
				Set Cmd: 2 & Reply: 2	0x0000 = display off 0x0001 = numeric only 0x0002 = thermometer only 0x0003 = numeric & thermometer	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
44	0x2C	DDE_GAIN	Enables / disables DDE and gets or sets the gain value for DDE in manual mode	Get Cmd: 0 (Reply: 2)	None	Range: 0 – 255 See para. 3.3.2.5 of Ref. 1 / Ref. 3 for definition of this parameter. *Note: Set capability has no effect in automatic DDE mode. (See SPATIAL_THRESHOLD, 0xE3.)*
				Set Cmd: 2 & Reply: 2	Gain value	
47	0x2F	SYMBOL_CONTROL	Sets symbol command. Also used to write user symbols. This command is non-blocking (see 3.2.2) if sent with byte count > 2. There is no associated status command.	Set Cmd: 2 & Reply: 2	0x0000=Symbol unfreeze 0x0001=Symbol freeze 0x0002=Symbol paint 0x0003=Symbol write	See FLIR's Tau website for an Application Note that provides a detailed explanation of the symbol-overlay capability.
				Set Cmd: 14-46	Bytes 0-1: Symbol Number (0-99) Bytes 2-3: Symbol Type 0x0000 = None 0x0001 = Rectangle 0x0002 = Text 0x0003 = Bitmap 0x0004 = Outline Rectangle Bytes 4-5: X-coord. < 0 = left, 0 = center, >1 = right Bytes 6-7: Y-coord. <0 = top, 0 = center, >1 = bottom Bytes 8-9: Width (rectangle) or Alignment (text) <0 = Left, 0 = center, >0 = Right Bytes 10-11: Height (rectangle) or Font (text) Byte 12: Background Color Byte 13: Foreground Color Bytes 14-45: Optional data Text characters or bitmap bytes	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
49	0x31	SPLASH_CONTROL	Gets/sets the Splash Screen delay parameters	Get Cmd: 0 (Reply: 4)	Bytes 0-1: Splash Screen # (0-1)	Range: 0 – 6000 (in video fields) See para. 3.3.1.1 of Ref. 1 / Ref. 3 for explanation of this parameter.
				Set Cmd: 4 & Reply: 4	Bytes 0-1: Splash Screen # (0-1) Bytes 2-3: Timeout period	
50	0x32	EZOOM_CONTROL	Continuous Zoom Controls	Get Cmd: 0		Width and increment / decrement value in pixels
				Reply: 2	Bytes 0-1: Current zoom width	
				Get Cmd: 2	Bytes 0-1: 0x0000: zoom width 0x0004: max. zoom width	
				Reply: 2	Bytes 0-1: requested value	
				Set Cmd: 4 (Reply: 0)	Bytes 0-1 0x0001: Set zoom width to specified value 0x0002: Increment zoom by specified value 0x0003: Decrement zoom by specified value Bytes 2-3: Specified value	
60	0x3C	FFC_WARN_TIME	Sets and gets FFC warn time	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 600 (frames) See para. 3.3.2.1 of Ref. 1 / Ref. 3 for explanation of this parameter.
				Set: 2 Reply: 2	Warn time (in frames)	
62	0x3E	AGC_FILTER	Gets or sets the AGC filter value	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 255 See para. 3.3.2.6.1 of Ref. 1 / Ref. 3 for explanation of this parameter.
				Set Cmd: 2 & Reply: 2	AGC filter value (0 = immediate)	
63	0x3F	PLATEAU_LEVEL	Specifies the plateau level for the Plateau AGC algorithm.	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 1000 See para. 3.3.2.6.1 of Ref. 1 / Ref. 3 for explanation of this parameter. It only applies to the plateau AGC algorithm.
				Set Cmd: 2 & Reply: 2	Plateau level	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
67	0x43	GET_SPOT_METER_DATA	Returns the value of the spot meter in degrees Celsius (regardless of spot meter mode). If the spot meter option is not enabled, returns the average value of the center four pixels.	Get Cmd: 0	None	See para. 3.3.3.1 of Ref. 3 for explanation of this feature.
				Reply: 2	Spot temperature value (in deg C) or average pixel value (in counts)	
			Gets the average, min & max pixel values for the spot-meter. Note: Not all configurations support the new advanced spot-meter capability.	Get Cmd: 2	Byte 0-1: format 0x0000 = reply in counts 0x0001 = reply in Celsius x 10 0x0002 = reply in Kelvin x 100	
				Reply: 20	Byte 0-1: sync flag	0x0000 = valid data 0x0001 = invalid data (e.g. during FFC)
					Byte 2-3: frame counter	LSB depends on frame rate
					Byte 4-5: Spot data (16-bit ave)	Mean average (14.2 fixed)
					Byte 6-7: Std Dev (16-bit)	14.2
					Byte 8-9: min value	14-bit min value
					Byte 10-11: max value	14-bit max value
					Byte 12-15: min X,Y coord	Min pixel X,Y-coordinate
					Byte 16-19: max X,Y coord	Max pixel X,Y-coordinate
		GET_SPOT_METER_COORDINATES	Get spot-meter coordinates	Get Cmd: 2	Bytes 0-1: 0x0100	
				Reply: 12	Byte 0 -1: sync flag	0x0000 = valid data 0x0001 = invalid data (e.g. during FFC)
					Byte 2-3: frame counter	LSB depends on frame rate
					Byte 4-7: left,top coord	Spot meter left,top (0-based)
					Byte 8-11: right,bottom coord	Spot meter right,bottom (0-based)
		SET_SPOT_METER_COORDINATES	Set spot-meter coordinates Note: Not all configurations support the moveable / resizeable spot-meter option.	Set Cmd: 8	Byte 0-3: left,top coord	Spot meter Left,top (0-based)
					Byte 4-7: right,bottom coord	Spot meter right,bottom (0-based)
				Reply: 4	Byte 0 -1: sync flag	0x0000 = valid data 0x0001 = invalid data (e.g. during FFC)
					Byte 2-3: frame counter	LSB depends on frame rate

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
76	0x4C	AGC_ROI	Gets or sets the Region of Interest (ROI) used by some of the AGC algorithms in normal and zoom modes. Assumes signed coordinates relative to center value of (0,0), and coordinates are expressed as percentages (-512 = -50%, +512 = +50%). See para. 3.3.2.4 of ref. 3 for a more complete explanation. Note: Unlike Tau 2.0, only a single ROI is defined for Tau 2.1. It is applied whether video is zoomed or unzoomed.	Get Cmd: 0	None	Range: ±512 (±50%) See para. 3.3.2.4 and 3.3.2.6 of Ref. 1 / Ref. 3 for explanation of this parameter. It does not apply to all AGC algorithms.
				Reply: 8	Bytes 0-1: Left Bytes 2-3: Top Bytes 4-5: Right Bytes 6-7: Bottom	
77	0x4D	SHUTTER_TEMP	Gets and sets the temperature of the shutter (both internal & external) as used for radiometry.	Get cmd: 0		
				Resp: 2	Bytes 0-1: Shutter temp in Deg Cx100	-5000..32767 DegC x 100
				Set cmd: 2 (Resp: 0)	Bytes 0-1: Shutter temp in Deg Cx100	32768 = Use Internal Tshut (default)
85	0x55	AGC_MIDPOINT	Gets or sets the AGC midpoint offset, a parameter used by the Plateau-Equalization and Linear AGC algorithms	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 255 See para. 3.3.2.6.1 of Ref. 1 / Ref. 3 for explanation of this parameter. It does not apply to all AGC algorithms.
				Set Cmd: 2 & Reply: 2	AGC midpoint	
101	0x65	SERIAL_NUMBER	Gets the serial number of the camera and sensor.	Get Cmd: 0	None	This command is redundant with 0x04 and is left to maintain backward compatibility.
				Reply: 8	Bytes 0-7: Serial number	
102	0x66	CAMERA_PART	Gets the camera part number	Get Cmd: 0	None	
				Reply: 32	Bytes 0-31: Part number (ASCII)	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
104	0x68	READ_ARRAY_ AVERAGE	Reads the mean of the current frame. This value is not ROI-dependent.	Get Cmd: 0	None	
				Reply: 4	Bytes 0-1: Mean in counts (+/-4 counts of rounding error) Bytes 2-3: histogram width in counts (+/- 4 counts of rounding error)	
106	0x6A	MAX_AGC_GAIN	Gets or sets the max-gain parameter for Plateau AGC	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 2047
				Set Cmd: 2 & Reply: 2	Max-AGC-gain parameter	See para. 3.3.2.6.1 of Ref. 1 / Ref. 3 for explanation of this parameter. It only applies to the plateau-equalization AGC algorithm.
112	0x70	PAN_AND_TILT	Gets or sets the pan (x axis) and tilt position (y axis) for the zoom window relative to the center of the unzoomed window.	Get Cmd: 0 (Reply: 4)	None	
				Set Cmd: 4 & Reply: 4	Bytes 0-1: Tilt position in rows Bytes 2-3: Pan position in columns	Limited to a range of -40 to +40 For advanced users, the pan/tilt range limits can be removed. Contact FLIR Applications Engineering for further details.
114	0x72	VIDEO_STANDARD	Gets or sets the video standard (affects frame rate)	Get Cmd: 0 (Reply: 2)	None	See para. 3.1.2.3 and 3.2.2 of Ref. 1 / Ref. 3 for explanation of these modes. Not all configurations support the 60Hz / 50Hz modes.
				Set Cmd: 2 & Reply: 2	0x0000 = NTSC, 30Hz 0x0001 = PAL, 25Hz 0x0002 = reserved 0x0003 = reserved 0x0004 = NTSC, 60Hz, 0x0005 = PAL, 50Hz	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
121	0x79	SHUTTER_POSITION	Gets or sets the shutter position This command is non-blocking (see 3.2.2). There is no associated status command.	Get Cmd: 0 (Reply: 2)	None	
				Set Cmd: 2 & Reply: 2	0x0000 = open 0x0001 = close 0xFFFF = unknown (valid for reply only, not for set)	
			Gets or sets the Shutter Profile (safety timeout + close/open table) used to close/open the shutter during FFC *Note: this capability is intended primarily for Quark users to signal an external shutter. Adjusting the drive profile of a Tau factory-installed shutter will likely cause the shutter to stop working properly and may cause permanent damage.*	Get Cmd: 0 (Reply: 34)	0x8000	See para. 3.3.2.1 of Ref. 1 for further explanation of this feature.
				Set Cmd: 34 & Reply: 34	Bytes 0-1: Safety Timeout (frames) Bytes 2-17: Close Shutter Table Bytes 18-33: Open Shutter Table	Range of Safety Timeout: 0 to 7000 (video fields), value of 0 means no safety timeout Table of 32 command "nibbles": Each entry = 1/60th second 0=idle, 1=open, 2=close Bit 3 (0x08)="normal" voltage bit
130	0x82	TRANSFER_FRAME	Captures a snapshot to a specified buffer location. (Capture operations must be sequential.) This command is non-blocking (see 3.2.2). There is no associated status command.	Cmd: 4 & Reply: 4	Byte 0: type 0x08 = 14-bit snapshot 0x16 = 8bit bitmap capture 0x17 = 8bit bitmap playback Byte 1: snapshot number Byte 2-3: 0x0001 For type 17, set bytes 2-3 to 0x0000 to resume live imagery.	The primary purpose of this command is to support the snapshot feature, described in para. 3.3.2.9 of Ref. 1 / Ref. 3. See FLIR's Tau website for an Application Note that provides a detailed explanation of the command sequences required to execute snapshot capture, playback, and download.

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
142	0x8E	TLIN_COMMANDS	Gets and sets the resolution of the TLinear digital video.	Get cmd: 2	Bytes 0-1: 0x0010	Output Mode: 0x0000 = Low resolution mode (0.4Kelvin/count in 14-bit digital) 0x0001 = High resolution mode (0.04 Kelvin/count in 14-bit digital)
				Resp: 2	Bytes 0-1: TLin Output Mode 0x0000 = Low resolution mode 0x0001 = High resolution mode	
				Set cmd: 4 Resp: 0	Bytes 0-1: 0x0010 Bytes 2-3: TLin Output Mode 0x0000 = Low resolution mode 0x0001 = High resolution mode	
			Enables/disables TLinear output Note: With TLinear enabled, the 14-bit digital output will represent scene temperature values. The 8-bit digital output and analog video output is unaffected.	Get cmd: 2	Bytes 0-1: 0x0040	Not all configurations support the TLinear capability. This feature can only be enabled if the camera supports advanced radiometry. See para.1.2 and 3.3.3.3 of Ref. 3
				Resp: 2	Bytes 0-1: TLin Enable Status	
				Set cmd: 4 Resp: 0	Bytes 0-1: 0x0040 Bytes 2-3: TLin Enable Status	
177	0xB1	CORRECTION_ MASK	Gets or sets the corrections applied This command allows various corrections / filters to be disabled. This feature is intended for advanced customers only and can degrade image quality.	Get Cmd: 0 (Reply: 2)	None	Valid arguments: 0x007F (all corrections enabled, non-advanced radiometry) 0x027F (all corrections enabled, advanced radiometry with TLinear enabled) 0x006F (to disable temp. filter)
				Set Cmd: 2 & Reply: 2	Correction mask: bit 0 -3: reserved bit 4 = temporal filter bit 5 - 15 = reserved	
196	0xC4	MEMORY_STATUS	Gets the status for several non-blocking write / erase commands	Cmd: 0	None	For various commands that involve writing or erasing non-volatile memory (e.g. SET_DEFAULTS, WRITE_NVFFC_TABLE, ERASE_MEMORY) this command returns status. Power should not be removed from the core until the command reports that the memory operation is complete.
				Reply: 2	Bytes remaining to be written 0x0000 = complete 0xFFFF = erase error 0xFFFE = write error	
198	0xC6	WRITE_NVFFC_ TABLE	Writes the FFC map to nonvolatile memory This command is non-blocking (see 3.2.2). The MEMORY_STATUS command (ID #196) is the associated status command.	Cmd: 0 & Reply: 0	None	See para. 3.3.2.1 of Ref. 1 / Ref. 3 for further explanation of this command.

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
210	0xD2	READ_MEMORY	Reads specified number of bytes beginning at the specified address	Cmd: 6	Bytes 0-3: Address Bytes 4-5: Number of bytes to read (maximum of 256)	Used for snapshot read. See the note associated with command ID 130 (0x82).
				Reply: Specified number of bytes	Up to 256 bytes of data	
212	0xD4	ERASE_MEMORY_ BLOCK	Erases a block or a range of non-volatile memory. This command is non-blocking (see 3.2.2). The MEMORY_STATUS command (ID #196) is the associated status command.	Cmd: 2 & Reply: 2	Block to be erased	Used for snapshot erase. See the note associated with command ID 130 (0x82).
213	0xD5	GET_NV_MEMORY_ SIZE	Get the base address and block size of the non-volatile memory device. (The memory block in which a particular address is located can be determined by subtracting the base address returned by GET_NV_MEMORY_SIZE from the memory address and then dividing the result by the block size returned by GET_NV_MEMORY_SIZE.)	Cmd: 2	0xFFFF	Used for snapshot read. See the note associated with command ID 130 (0x82).
				Reply: 8	Bytes 0-3: Base Address Bytes 4-7: Block Size (in bytes)	
214	0xD6	GET_MEMORY_ ADDRESS	Gets the memory address and size of the specified buffer.	Cmd: 4	Bytes 0-3: FFFF 0013	Used for snapshot read. See the note associated with command ID 130 (0x82). Note that the number of used bytes in the snapshot area includes headers. Consequently, even when all snapshots are erased, the returned value will be non-zero.
				Reply: 8	Bytes 0-3: Base address of snapshot area Bytes 4-7: Size (in bytes)	
				Cmd: 4	Bytes 0-3: FFFE 0013	
				Reply: 8	Bytes 0-3: Number of used bytes in snapshot area Bytes 4-7: Total number of snapshots in snapshot area	
				Cmd: 4	Bytes 0-3: 00XX 0013	
				Reply: 8	Bytes 0-3: Address of snapshot XX Bytes 4-7: Size (in bytes) of snapshot XX	
				Cmd: 4	Bytes 0-3: 80XX 0013	
				Reply: 8	Bytes 0-3: 4-byte header stored with snapshot XX Bytes 4-7: Null	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
219	0xDB	GAIN_SWITCH_ PARAMS	Gets or sets the population (as a percentage) and temperature (in deg C) thresholds for automatic high/low gain-state switching For example, if the hi-to-lo temp threshold is set to 100 and the hi-to-low population threshold is set to 20, the automatic switch to low gain state will occur when ≥ 20% of the ROI is imaging temps ≥100C. If the low-to-high temp threshold is set to 90 and the low-to-high population threshold is set to 85, the automatic switch to high gain will occur when ≥85% of the ROI is imaging temps < 90C.	Get Cmd: 0 (Reply: 8)	None	Pop. thresholds range: 0 to 100 Temp. thresholds range: 50 to 160 Note: to prevent oscillation between gain states, high-to-low temperature threshold must be greater than low-to-high threshold. Similarly the sum of the two population thresholds must be greater than 100%. See para. 3.3.2.2 of Ref. 1 / Ref. 3 for further explanation of these parameters.
				Set Cmd: 8 & Reply: 8	Bytes 0-1: high-to-low temperature threshold Bytes 2-3: high-to-low population threshold Bytes 4-5: low-to-high temperature threshold Bytes 6-7: low-to-high population threshold	
226	0xE2	DDE_THRESHOLD	Gets or sets the threshold of the DDE filter	Get Cmd: 0 (Reply: 2)	None	Range: 0 to 255 See para. 3.3.2.5 of Ref. 1 / Ref. 3 for definition of this parameter. Note: Set capability has no effect in automatic DDE mode. (See SPATIAL_THRESHOLD, 0xE3.)
				Set Cmd: 2 & Reply: 2	Threshold value	
227	0xE3	SPATIAL_ THRESHOLD (AUTO_DDE)	Gets or sets the spatial threshold of the DDE filter and the DDE mode (auto or manual)	Get Cmd: 0 (Reply: 2)	None	See para. 3.3.2.5 of Ref. 1 / Ref. 3 for definition of this parameter.
				Set Cmd: 2 & Reply: 2	Bytes 0 -1: 0x0000 – 0x000F = manually specified threshold 0x0100 – 0x013F automatic threshold (0 to 63)	

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
229	0xE5	LENS_RESPONSE_ PARAMS	Gets and sets the lens parameters for the calculated responsivity. Note: not all configurations support advanced radiometry	Get cmd: 2	Bytes 0-1: Lens #	0=Lens #0, 1=Lens #1
				Resp: 4	Bytes 0-1: F/#	4096-65535 (0.5-7.9999)
					Bytes 2-3: Transmission	4096-8192 (0.5-1.0)
				Set cmd: 6 (Resp: 0)	Bytes 0-1: Lens #	0=Lens #0, 1=Lens #1
					Bytes 2-3: F/# 0xFFFF doesn't "set"	4096-65535 (0.5-7.9999)
					Bytes 4-5: Transmission 0xFFFF doesn't "set"	4096-8192 (0.5-1.0)
			Gets and sets the scene parameters for radiometric calculations Note: not all configurations support advanced radiometry	Get cmd: 2	Bytes 0-1: Parameter	0x0100=RAD_EMISSIVITY
				Resp: 2	Bytes 0-1: Value	4096-8192 (0.5-1.00)
				Set cmd: 4 (Resp: 0)	Bytes 0-1: Parameter	0x0100=RAD_EMISSIVITY
					Bytes 2-3: Value	4096-8192 (0.5-1.00)
				Get cmd: 2	Bytes 0-1: Parameter	0x0101=RAD_TBKG_X100
				Resp: 2	Bytes 0-1: Value	S15.0 (-50.00-327.67)
				Set cmd: 4 (Resp 0)	Bytes 0-1: Parameter	0x0101=RAD_TBKG_X100
					Bytes 2-3: Value	S15.0 (-50.00-327.67)
				Get cmd: 2	Bytes 0-1: Parameter	0x0102=RAD_TRANSMISSION_WIN
				Resp: 2	Bytes 0-1: Value	4096-8192 (0.5-1.0)
				Set cmd: 4 (Resp 0)	Bytes 0-1: Parameter	0x0102=RAD_TRANSMISSION_WIN
					Bytes 2-3: Value	4096-8192 (0.5-1.0)
				Get cmd: 2	Bytes 0-1: Parameter	0x0103= RAD_TWIN_X100
				Resp: 2	Bytes 0-1: Value	S15.0 (-50.00-327.67)
				Set cmd: 4	Bytes 0-1: Parameter	0x0103= RAD_TWIN_X100
				Resp: 0	Bytes 2-3: Value	S15.0 (-50.00-327.67)
				Get cmd: 2	Bytes 0-1: Parameter	0x0104= RAD_TAU_ATM
				Resp: 2	Bytes 0-1: Value	4096-8192 (F3.13 0.5-1.0)
				Set cmd: 4	Bytes 0-1: Parameter	0x0104=RAD_TAU_ATM

Table 3-5 Function Byte Codes, All Commands

ID	Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
				Resp: 0	Bytes 2-3: Value	4096-8192 (F3.13 0.5-1.0)
				Get cmd: 2	Bytes 0-1: Parameter	0x0105= RAD_TATM_X100
				Resp: 2	Bytes 0-1: Value	S15.0 (-50.00-327.67)
				Set cmd: 4	Bytes 0-1: Parameter	0x0105=RAD_TATM_X100
				Resp: 0	Bytes 2-3: Value	S15.0 (-50.00-327.67)
				Get cmd: 2	Bytes 0-1: Parameter	0x0106=RAD_ REFL _WIN
				Resp: 2	Bytes 0-1: Value	0- RAD_TAU_WIN (F3.13 0.0-τ_{win})
				Set cmd: 4	Bytes 0-1: Parameter	0x0106=RAD_REFL_WIN
				Resp: 0	Bytes 2-3: Value	0- RAD_TAU_WIN (F3.13 0.0-τ_{win})
				Get cmd: 2	Bytes 0-1: Parameter	0x0107=RAD_ TREFL _X100
				Resp: 2	Bytes 0-1: Value	S15.0 (-50.00-327.67)
				Set cmd: 4	Bytes 0-1: Parameter	0x0107=RAD_ TREFL _X100
				Resp: 0	Bytes 2-3: Value	S15.0 (-50.00-327.67)

3.3 Summarized Command Lists

The lists below are subsets of Table 2-4, each showing all the commands related to a particular aspect of Tau 2 / Quark operation.

List of FFC-related commands:

ID	Function Code (hex)	Command
11	0x0B	FFC_MODE_ SELECT
12	0x0C	DO_FFC
13	0x0D	FFC_PERIOD
14	0x0E	FFC_TEMP_ DELTA
60	0x3C	FFC_WARN_TIME
121	0x79	SHUTTER_POSITION
198	0xC6	WRITE_NVFFC_TABLE

List of commands related to Analog Video / BT.656 digital video and AGC:

ID	Function Code (hex)	Command
15	0x0F	VIDEO_MODE
16	0x10	VIDEO_PALETTE
19	0x13	AGC_TYPE
20	0x14	CONTRAST
21	0x15	BRIGHTNESS
24	0x18	BRIGHTNESS_BIAS
37	0x25	TEST_ PATTERN
38	0x26	VIDEO_COLOR_MODE
43	0x2B	SPOT_DISPLAY
47	0x2F	SYMBOL_CONTROL
49	0x31	SPLASH_CONTROL
50	0x32	EZOOM_CONTROL
62	0x3E	AGC_FILTER
63	0x3F	PLATEAU_LEVEL
76	0x4C	AGC_ROI
85	0x55	AGC_MIDPOINT
106	0x6A	MAX_AGC_GAIN
112	0x70	PAN_AND_TILT
114	0x72	VIDEO_STANDARD

List of radiometry-related commands:

ID	Function Code (hex)	Command
10	0x0A	GAIN_MODE
31	0x1F	SPOT_METER_ MODE
34	0x22	ISOTHERM
35	0x23	ISOTHERM_ THRESHOLDS
42	0x2A	GET_SPOT_METER
43	0x2B	SPOT_DISPLAY
67	0x43	GET_SPOT_METER_ DATA
77	0x4D	SHUTTER_TEMP
142	0x8E	TLIN_COMMANDS
219	0xDB	GAIN_SWITCH_ PARAMS
229	0xE5	LENS_RESPONSE_PARAMS

List of DDE-related commands:

ID	Function Code (hex)	Command
44	0x2C	DDE_GAIN
226	0xE2	DDE_THRESHOLD
227	0xE3	SPATIAL_ THRESHOLD (AUTO_DDE)

List of snapshot-related commands:

ID	Function Code (hex)	Command
130	0x82	TRANSFER_FRAME
196	0xC4	MEMORY_STATUS
210	0xD2	READ_MEMORY
212	0xD4	ERASE_MEMORY_ BLOCK
213	0xD5	GET_NV_MEMORY_SIZE
214	0xD6	GET_MEMORY_ ADDRESS

Note: See FLIR's Tau website for an Application Note that provides a detailed explanation of the proper command sequences to implement snapshot capture, playback, and download.

3.4 Example format of a serial message

The packet depictions below illustrate the incoming message when the FFC_MODE_SELECT command (0x0B) is issued to get current setting and the reply message assuming the current FFC mode is "automatic" (argument = 0x0001):

Incoming message:

Process Code	Status	Reserved	Function	Byte Count	CRC	Data	CRC
0x6E	0x00	0x00	0x0B	0x0000	0x2F4A		0x0000

Reply message:

Process Code	Status	Reserved	Function	Byte Count	CRC	Data	CRC
0x6E	0x00	0x00	0x0B	0x0002	0x0F08	0x0001	0x1021

3.5 Parameters Affected by SET_DEFAULTS & RESTORE_FACTORY_DEFAULTS

Table 3-6 shows the list of parameters that can be modified by the customer and then stored as power-on defaults via the SET_DEFAULTS command (0x01). It is also possible to restore factory-default values (i.e., the original power-on defaults selected by FLIR) via the RESTORE_FACTORY_DEFAULTS command (0x03). The factory-default values are also shown in Table 3-6.

Note: RESTORE_FACTORY_DEFAULTS does not restore parameter values as power-on defaults, only as currently applied settings. If it is desired to restore factory defaults as power-on defaults, the RESTORE_FACTORY_DEFAULTS command should be followed by the SET_DEFAULTS command.

Table 3-6 Parameters Affected by SET_DEFAULTS and RESTORE_FACTORY_DEFAULTS

Parameter	Factory Default	Command Used to Set Parameter	Cmd ID#
Baud Rate	0x0000 (Auto baud)	BAUD_RATE	7
Gain Mode	Varies by configuration.	GAIN_MODE	10
FFC Mode	Varies by configuration	FFC_MODE_SELECT	11
FFC Interval (High-Gain State)	0x0E10 (3600 frames)	FFC_PERIOD	13
FFC Interval (Low-Gain State)	0x0546 (1350 frames)	FFC_PERIOD	13
FFC Temp Interval (High-Gain State)	0x000A (1.1C)	FFC_TEMP_DELTA	14
FFC Temp Interval (Low-Gain State)	0x000A (1.1C)	FFC_TEMP_DELTA	14
Video Palette	0x0000 (Palette 0 = white hot)	VIDEO_PALETTE	16
Video Mode	0x0000 (Real-time, unzoomed)	VIDEO_MODE	15
Video Orientation	0x0000 (Normal orientation)	VIDEO_ORIENTATION	17
Digital Output Modes	Varies by configuration	DIGITAL_OUTPUT_ MODE	18
AGC Algorithm	0x0000 (Plateau Equalization)	AGC_TYPE	19
Contrast	0x0020 (32)	CONTRAST	20
Brightness	0x2000 (8192)	BRIGHTNESS	21
Brightness Bias	0x0000 (0)	BRIGHTNESS_BIAS	22
Lens Number	0x0000 (0)	LENS_NUMBER	30
Spot Meter Mode	Varies by configuration	SPOT_METER_MODE	31
External Sync Mode	0x0000 (Disabled)	EXTERNAL_SYNC	33

Parameter	Factory Default	Command Used to Set Parameter	Cmd ID#
Isotherm Mode	Varies by configuration	ISOTHERM	34
Lower Isotherm Threshold	0x005A (90%)	ISOTHERM_ THRESHOLDS	35
Middle Isotherm Threshold	0x005C (92%)	ISOTHERM_ THRESHOLDS	35
Upper Isotherm Threshold	0x005F (95%)	ISOTHERM_ THRESHOLDS	35
Video Color Mode	0x0001 (Color enabled)	VIDEO_COLOR_MODE	38
Spot Display Mode	Varies by configuration	SPOT_DISPLAY	43
DDE Gain	n/a (auto)	DDE_GAIN	44
Ezoom Width	Max value (varies by config.)	EZOOM_CONTROL	50
FFC Warn Time	0x003C (60 frames)	FFC_WARN_TIME	60
AGC Filter	0x0040 (64)	AGC_FILTER	62
Plateau Level	0x0096 (150)	PLATEAU_LEVEL	63
Spot Meter Coordinates	Varies by configuration	GET_SPOT_METER_ DATA	67
ROI Coordinates	Top: -50% Left: -50% Bottom: +50% Right: +50%	AGC_ROI	76
2X Zoom ROI Coordinates	Not used in Tau 2.1	AGC_ROI	76
4X Zoom ROI Coordinates	Not used in Tau 2.1	AGC_ROI	76
8X Zoom ROI Coordinates	Not used in Tau 2.1	AGC_ROI	76
AGC Midpoint	0x007F (127)	AGC_MIDPOINT	85
Max. Gain	0x000C (12)	MAX_AGC_GAIN	106
Pan / Tilt Coordinates	0,0	PAN_AND_TILT	112
Video Standard	Varies by configuration	VIDEO_STANDARD	114
TLinear Enable	Varies by configuration	TLIN_COMMANDS	142
TLinear Resolution	Varies by configuration	TLIN_COMMANDS	142
Shutter Profile	Varies by configuration	SHUTTER_POSITION	121
Correction Mask	0x003F (all enabled)	CORRECTION_MASK	177
Gain Switch, High-to-Low Temperature Threshold	0x008C (140C)	GAIN_SWITCH_PARAMS	219
Gain Switch, Low-to-High Temperature Threshold	0x0064 (100C)	GAIN_SWITCH_PARAMS	219

Parameter	Factory Default	Command Used to Set Parameter	Cmd ID#
Gain Switch, High-to-Low Population Threshold	0x005F (95%)	GAIN_SWITCH_PARAMS	219
Gain Switch, Low-to-High Population Threshold	0x0014 (20%)	GAIN_SWITCH_PARAMS	219
DDE Threshold	n/a (default mode is automatic)	DDE_THRESHOLD	226
DDE Mode / Spatial Threshold	0x0119 (25, automatic mode)	SPATIAL_THRESHOLD	227
Lens Response Parameters	Varies by configuration	LENS_RESPONSE_ PARAMETERS	229

If you have questions that are not covered in this manual, or need service, contact FLIR Commercial Systems Customer Support at 805.964.9797 for additional information prior to returning a camera.

This documentation and the requirements specified herein are subject to change without notice.

This equipment must be disposed of as electronic waste.
Contact your nearest FLIR Commercial Systems, Inc. representative for instructions on how to return the product to FLIR for proper disposal.

FCC Notice. This device is a subassembly designed for incorporation into other products in order to provide an infrared camera function. It is not an end-product fit for consumer use. When incorporated into a host device, the end-product will generate, use, and radiate radio frequency energy that may cause radio interference. As such, the end-product incorporating this subassembly must be tested and approved under the rules of the Federal Communications Commission (FCC) before the end-product may be offered for sale or lease, advertised, imported, sold, or leased in the United States. The FCC regulations are designed to provide reasonable protection against interference to radio communications. See 47 C.F.R. §§ 2.803 and 15.1 et seq.

Industry Canada Notice. This device is a subassembly designed for incorporation into other products in order to provide an infrared camera function. It is not an end-product fit for consumer use. When incorporated into a host device, the end-product will generate, use, and radiate radio frequency energy that may cause radio interference. As such, the end-product incorporating this subassembly must be tested for compliance with the Interference-Causing Equipment Standard, Digital Apparatus, ICES-003, of Industry Canada before the product incorporating this device may be: manufactured or offered for sale or lease, imported, distributed, sold, or leased in Canada.

Avis d'Industrie Canada. Cet appareil est un sous-ensemble conçu pour être intégré à un autre produit afin de fournir une fonction de caméra infrarouge. Ce n'est pas un produit final destiné aux consommateurs. Une fois intégré à un dispositif hôte, le produit final va générer, utiliser et émettre de l'énergie radiofréquence qui pourrait provoquer de l'interférence radio. En tant que tel, le produit final intégrant ce sous-ensemble doit être testé pour en vérifier la conformité avec la Norme sur le matériel brouilleur pour les appareils numériques (NMB-003) d'Industrie Canada avant que le produit intégrant ce dispositif puisse être fabriqué, mis en vente ou en location, importé, distribué, vendu ou loué au Canada.

EU Notice. This device is a subassembly or component intended only for product evaluation, development or incorporation into other products in order to provide an infrared camera function. It is not a finished end-product fit for general consumer use. Persons handling this device must have appropriate electronics training and observe good engineering practice standards. As such, this product does not fall within the scope of the European Union (EU) directives regarding electromagnetic compatibility (EMC). Any end-product intended for general consumer use that incorporates this device must be tested in accordance and comply with all applicable EU EMC and other relevant directives.