OLYMPUS®

i-SPEED TR
i-SPEED 3
i-SPEED FS
i-SPEED DF

INSTRUCTIONS
High Speed Video Camera System

Contents

Important Information — Please Read Before Use

Intended use

This instrument has been designed to capture video of high speed events, store the captured video in internal memory and subsequently replay the video at slower speeds. The camera may also be used to pass the stored video to a computer via Ethernet or save it to a Compact Flash card.

Instruction manual

This instruction manual contains essential information on using this equipment safely and effectively. Before use, thoroughly review this manual and the manuals of all equipment which will be used during the procedure and use the equipment as instructed.

Keep this and all related instruction manuals in a safe, accessible location.

If you have any questions or comments about any information in this manual, please contact Olympus.

Repair and modification

The camera has a replaceable fuse on the rear panel and does not contain any other user–serviceable parts. Do not disassemble, modify or attempt to repair, user injury and/or equipment damage can result. Please contact Olympus for service/repair.

Signal words

The following signal words are used throughout this manual:

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices or potential equipment damage.

NOTE

Indicates additional helpful information.

Warnings and cautions

Follow the warnings and cautions given below when handling this instrument.

WARNING

- Do not operate the equipment in the presence of combustible gases or vapours, this could cause a fire or explosion. If in any doubt about the operating environment, contact Olympus.
- Do not operate the equipment in the presence of airborne conductive powders, this could damage the equipment or cause a fire. If in any doubt about the operating environment, contact Olympus.
- In order to indicate the various operating modes of the camera, the *i*-CHEQ status indicator makes use of flashing light sequences. The maximum flash rate is less than 8Hz, which is not thought to trigger an epileptic fit in the vast majority of sufferers. However, if the user has a history of epilepsy, it is recommended that the risk of triggering a fit is carefully considered before operating this camera.
- When operating from mains power, only use the power supply provided. The power supply must be connected to a suitably grounded AC outlet.
- The power supply must be accessible at all times during use so that it can be easily disconnected from the mains power supply in the event of an emergency.
- Use of other power supplies may cause EMC problems and cause the camera to become unearthed.

- Ensure all equipment is earthed (grounded) to the same potential as the camera prior to operation. Failure to earth equipment may result in electric shock.
- The emergency backup battery is a customised Lithium Ion unit and should not be replaced with any other battery, even if it looks the same and is the same size. It is a high energy unit and must be treated with care.
- The emergency backup battery should only be charged in the camera or with a charger specifically recommended by Olympus.
- The emergency backup battery must never be:
  - short circuited
  - punctured, dismantled, physically shocked or deformed
  - heated above 60°C
  - cooled below -20°C
  - disposed of in fire
  - immersed in liquid

CAUTION

- Do not operate the camera from the battery of a positive earth vehicle. Damage, fire or injury could occur if the case of the camera touches the body of the vehicle because the case of the camera is connected to the negative power input.
- If the fuse is replaced, ensure that a fuse of the correct type and rating is used.
- Do not operate the equipment, or any accessories such as a borescope or fibrescope, in live electrical equipment as electric shock or short circuit may occur, resulting in equipment damage, fire or injury to the user.
- Do not operate the equipment, or any accessories such as a borescope or fibrescope, in moving machinery as physical injury to the user may result.
- The camera should be securely mounted to a tripod or support structure during use.
- Ensure that the camera cables are routed safely out of the way of moving equipment. Ensure that cables do not cause a trip hazard.
- This equipment has no resistance to fluid ingress - do not use the equipment where contact with fluid is likely or already suspected.
- When a recorded image is frozen on the display, take care not to touch subject equipment which may still be moving.

- The case and internal foam are flammable and are susceptible to damage by heat or fire. Do not expose the case or foam to fire or intense sources of heat.
- Ensure that the glass window inside the lens mount is clean and free of debris at all times.
- Before operating the unit, check that cooling vents are not blocked or obstructed.
- The measurement suite is intended to give a good indication of relative object measurement. However, due to the number of variable factors involved, no guarantee of measurement accuracy can be given.
- Only *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF cameras that are high-G rated may be used for high-G applications. The high-G versions of these cameras are marked on their serial number label with the letters HG. The mains power supply and CDU are not G-rated. Subjecting the CDU or power supply to high-G environments may damage the units and could present a risk of electric shock.
- Avoid subjecting the unit to heavy knocks or shock loadings, as these will reduce the effective life and reliability of the components within the unit.
- Do not remove the Compact Flash card while the Compact Flash card removal warning is visible on the CDU menu screen. This may result in data corruption or damage to the Compact Flash card.

General notes

- The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF software runs on Microsoft Windows 2000, Windows XP, Windows Vista or Windows 7. For the basic operating procedures of these operating systems, refer to the operating system manual.
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End–user license agreement

NOTE

This license agreement applies to the software supplied on disk with the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF system and not the camera itself.

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Chapter 1 Introduction

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF are self-contained high speed video cameras. This means that it contains all the functionality required to obtain high speed video and does not require the presence of a PC, although PC connection is possible if required. The camera has been designed to be used in two ways as follows:

Controller Display Unit

The Controller Display Unit (CDU) is available as an optional accessory for the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF. This product displays the image from the camera in real-time and permits the most flexible use of the camera, by using a series of buttons around the outside of the screen. The bottom seven buttons are used as “soft keys”, that is, the function of each button is dependent on the text written above it on the screen. The four buttons on the right hand side have dedicated functions and these are Text, Back, Up and Down. The menu system has been specially constructed to take maximum advantage of this layout. CDU operation of the camera is described in detail in Chapter 7 of this manual.

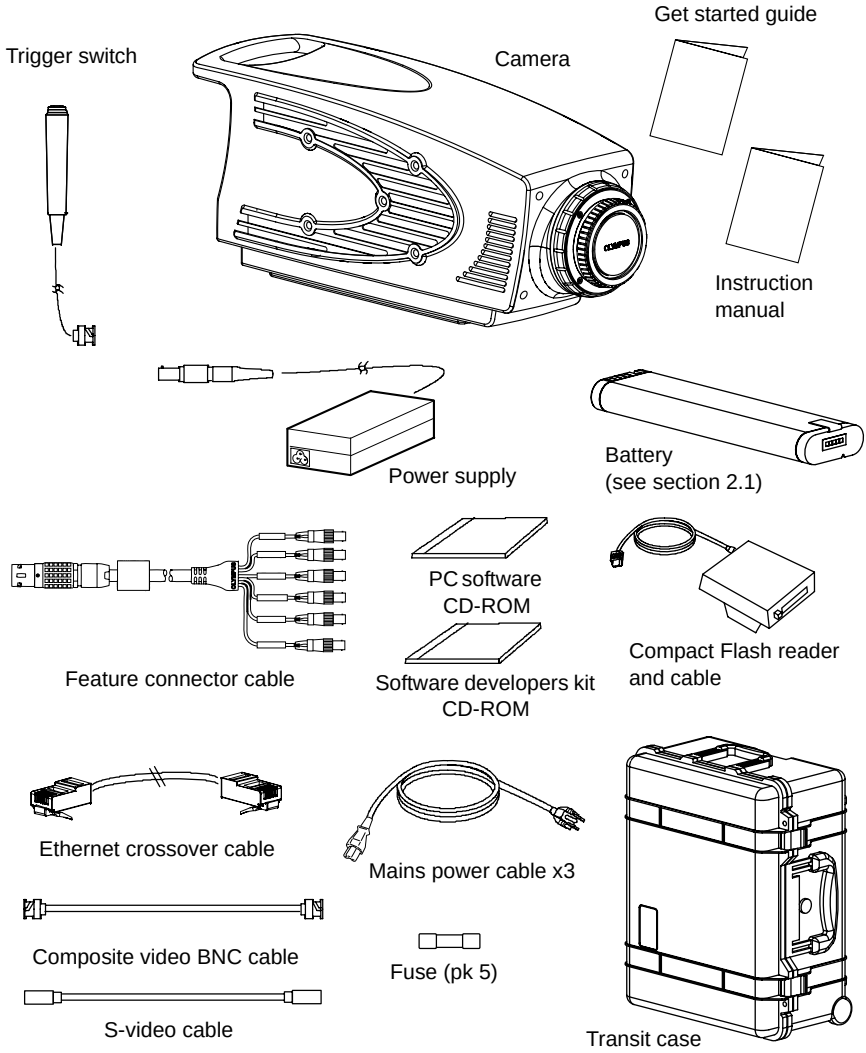
PC/Laptop Connection

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF may be connected to a PC or laptop via the Ethernet connector and an appropriate Ethernet network. In this case, the unit is controlled from the PC / laptop and the image is visible on the PC screen. This requires the PC to be running the basic control program which is supplied on a CD ROM with the camera. Upgrade options are available for the supplied software and these provide additional functionality. Details of the upgrades are available from Olympus representatives, see Chapter 11. In Ethernet mode, all the functions of the camera are available, but they are presented and controlled by the PC software.

For details of the operation of this software, reference should be made to the documentation supplied with the software. Information regarding the camera, however, is contained in the Reference sections of this manual.

Chapter 2 Checking the Package Contents

Remove the transit sleeve and open the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF system case. Match all items in the case with the items shown below. If any item is missing or damaged contact Olympus.



Item	***i*-SPEED TR**	***i*-SPEED 3**	***i*-SPEED FS**	***i*-SPEED DF**
Camera	O	O	O	O
Battery	–	O	O	O
Mains powercable x3	O	O	O	O
Controller Display Unit (CDU)	–	–	–	–
CDU connector cable	–	–	–	–
Power supply	O	O	O	O
Trigger switch	O	O	O	O
Composite video BNC cable	O	O	O	O
S- video cable	O	O	O	O
Feature connector cable	–	O	O	O
Ethernet crossover cable	O	O	O	O
Compact Flash reader and cable	O	O	O	O
PC software CD-ROM	O	O	O	O
Software developers kit CD-ROM	–	–	–	O
Instruction manual	O	O	O	O
Getting started guide	O	O	O	O
Fuse (pk 5)	O	O	O	O
Transit case	O	O	O	O

2.1 Battery installation

The Lithium Ion emergency backup battery is shipped in a separate compartment in the foam insert in the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF case. Before use, the user should install the battery as follows.

1. Undo the four captive screws and remove the battery cover, noting the cut out is positioned at the top.

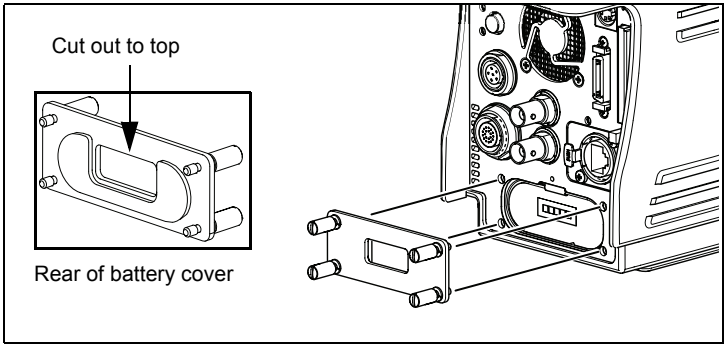


Figure 2.1

2. Slide the battery into the battery housing with the tab and battery contacts to the top. Tuck the tab into the slot and ensure the battery is pushed fully home (Figure 2.2 inset).

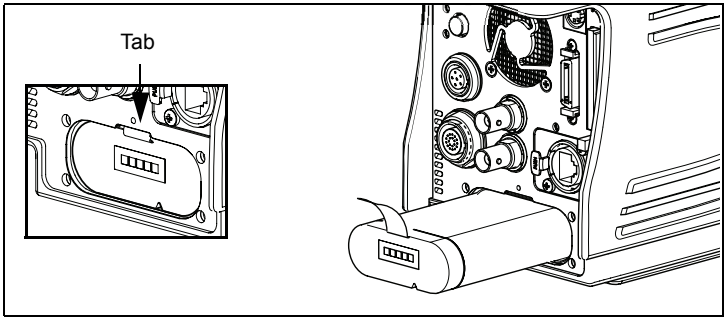


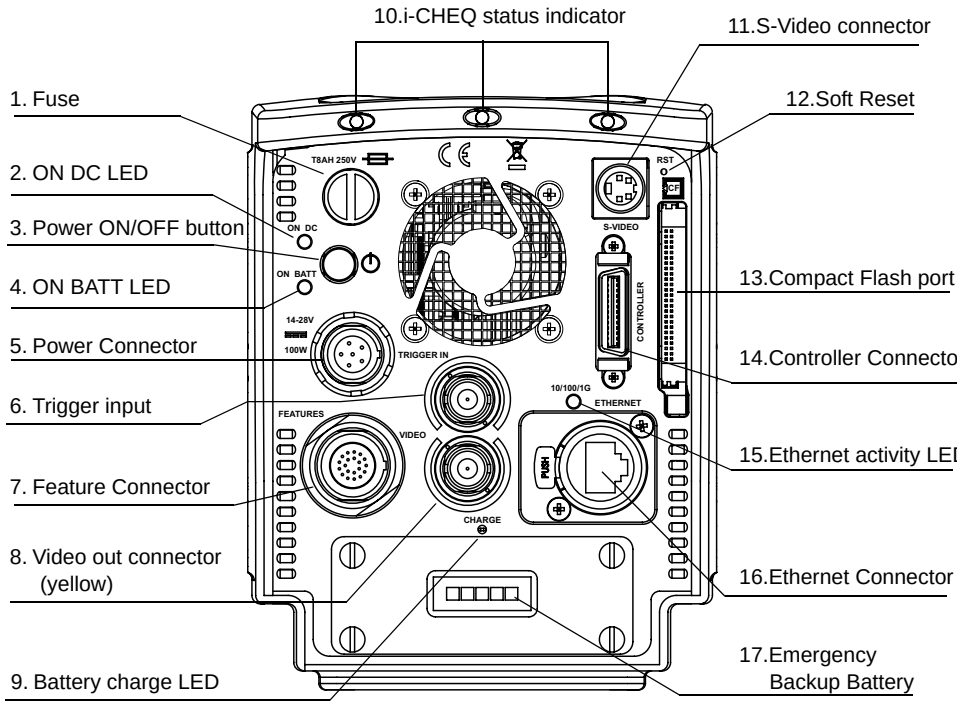
Figure 2.2

3. Replace the battery cover noting that the cut out should be to the top (Figure 2.1 inset). Tighten the four captive screws.

A comprehensive description of the battery is given in Section 3.2.

Chapter 3 Nomenclature and Functions

3.1 Camera



1. Fuse

The fuse is replaceable by the user and is accessed by unscrewing the fuse holder. Care must be taken to replace the fuse with one of the correct size, type and rating.

2. ON DC LED

When the camera is turned on and is taking power from the DC power input, this LED will illuminate green.

3. Power ON/OFF button

WARNING

- In order to indicate the various operating modes of the camera, the *i*-CHEQ status indicator makes use of flashing light sequences. The maximum flash rate is less than 8Hz, which is not thought to trigger an epileptic fit in the vast majority of sufferers. However, if the user has a history of epilepsy, it is recommended that the risk of triggering a fit is carefully considered before operating this camera.

To switch the camera on, press the power button briefly.

To turn the camera off press and hold the power button for 4 seconds. The *i*-CHEQ status indicators in the handle / protective bar will rapidly flash blue / red, and will extinguish from the right hand side as the timeout period progresses. Power off will occur around the time that all lights are out. The timeout and flashing lights are intended to provide the maximum protection against accidental switch-off.

The preferred method of turning the camera off is by using the button in the CDU home menu. Protection against accident is provided by a confirmation box.

NOTE

Attempting to turn the camera off by removing DC power will fail, because the camera will automatically switch to battery.

4. ON BATT LED

When the camera is turned on and is taking power from the battery, this LED light will illuminate red.

5. Power Connector

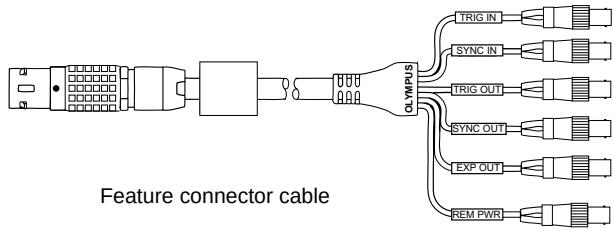
The rear panel power connector is used to take power into the camera, between 14V and 28V DC. The power input is protected against reverse polarity connection and this will normally result in a blown fuse.

6. Trigger input

Except for *i*-SPEED FS cameras, this input is electrically connected to the Trigger Input in the feature connector. Throughout this manual reference is made to the connection and use of the Trigger Input via the Feature Lead. This does not apply to *i*-SPEED FS cameras whose dedicated Trigger Input BNC connector must be used instead. Refer to "Chapter 8 Special features of the i-SPEED FS". It is provided for users who do not wish to use the feature cable but still wish to use a trigger. For further details, please see the sub-section **Trigger Input / Trigger Switch** in paragraph 7. below.

7. Feature Connector

This connector contains a number of signals. They are gathered together in one connector to reduce the size of the camera's back panel and thereby permit the manufacture of the smallest possible unit. In order to gain access to the signals in this connector, a feature connector cable is supplied and this terminates in a series of connectors, labelled as follows:



Feature connector cable

Trigger Input / Trigger Switch: This connector (and the supplied trigger switch if required) are used to trigger the camera while recording is in progress. Further details are provided in "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF".

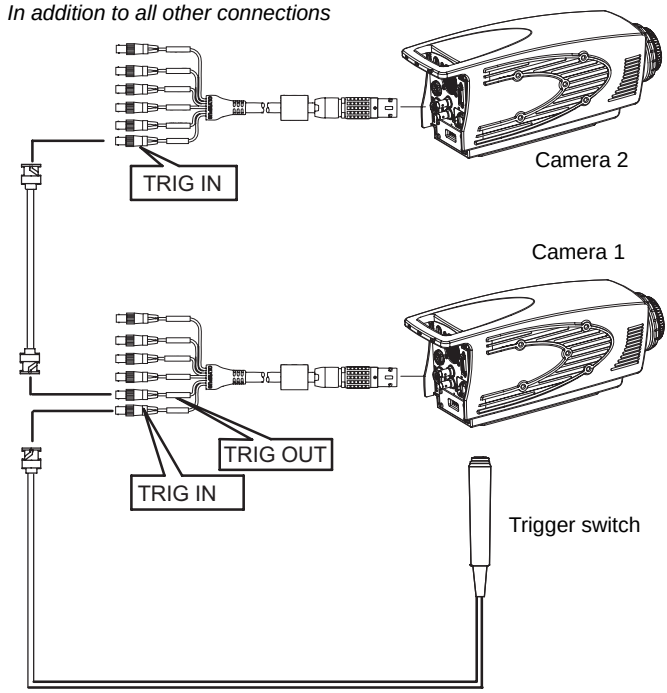
When the trigger is set to 0%, the trigger counter is set to the length of the memory, so that the trigger point appears at the beginning (0%) of the final video clip. A setting of 100% will cause the recording to stop immediately, placing the trigger event at the end of the video clip.

The signal is TTL level and the user may select rising edge or falling edge trigger options.

The trigger input contains a “pull-up” resistor to enable the supplied trigger switch to be used without further electronics. It should be noted that the trigger switch provides a falling edge. In practice, the trigger switch also produces a rising edge because of switch bounce, but this cannot be guaranteed.

Trigger Output: This output is TTL compatible and gives a 1 microsecond wide active high pulse. The rising edge signifies the start of the first integration period of the sensor to occur after recording has stopped. This connector may be used to cause another camera to trigger after the end of this camera’s recording. In this way a series of cameras may work in a daisy chain.

When daisy chain operation is used, the first camera’s trigger point may be selected by the user, but it is recommended that the second camera’s trigger position is set to 0%.


In addition to all other connections
TRIG IN
Camera 2
Camera 1
TRIG OUT
TRIG IN
Trigger switch

Sync Input:

The camera's frame rate may be determined by an external signal source. All variants of *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF have an Auto synchronisation mode. Additionally *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF have a Random Snapshot synchronisation mode. *i*-SPEED FS cameras can also be synchronised to an IRIG timing signal (refer to "Chapter 8 Special features of the i-SPEED FS") and *i*-SPEED DF cameras have a double frame sync mode for PIV applications.

The input is TTL compatible and the active edge is user selectable. The active edge signifies the start of the integration (exposure) period.

In Auto mode, typically a constant frequency signal is fed to multiple cameras. The source of this signal can be an *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS or *i*-SPEED DF camera utilising the Sync output connection. In this case, the camera would not only lock its frame rate to that of the other camera, but the exact moment at which each frame is captured would also be locked to the other camera (to within 1µs). In this way, it is possible to have multiple cameras viewing one event and taking images simultaneously.

The camera constantly monitors the sync input and will automatically enter external sync lock when an incoming sync is detected. To achieve lock, the incoming sync frequency must remain stable to within 1% for at least 2 seconds.

During the lock process, the camera will constrain the shutter to a maximum of 98% of the available time and will set the shutter control mode to Time. The camera will also set the resolution to a size which would allow for a small drift in the speed, so use at around 3000fps or above (correct at time of going to press) will result in a lower resolution than unsynchronised operation.

The frequency range over which sync may be achieved is 24fps to 10,000fps for *i*-SPEED TR, 24fps to 150,000fps for *i*-SPEED 3, 24fps to 1,000,000fps for *i*-SPEED FS and 24fps to 300,000fps for *i*-SPEED DF. The camera will synchronise to any frequency in this range, but it may offset or jitter by up to 1µs relative to the incoming sync pulses.

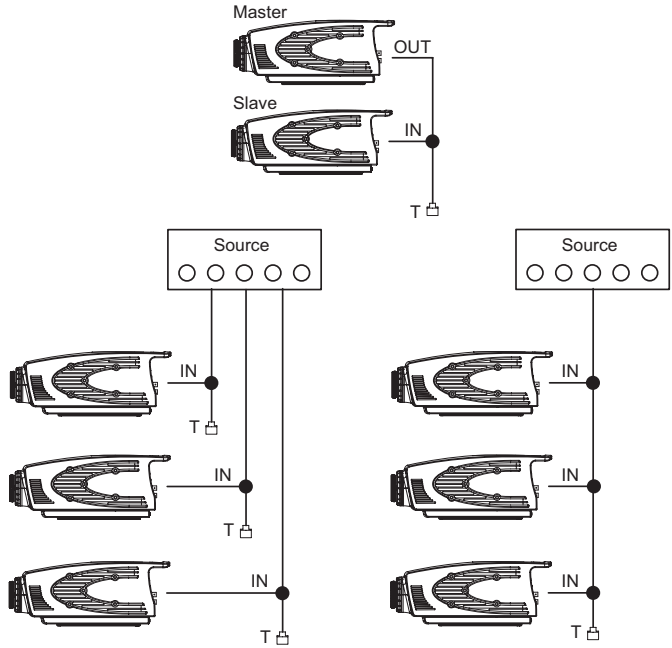
Once in lock, the camera will follow the incoming sync frequency, even if it changes. The range of upwards change is limited; the camera will lose lock if the incoming frequency is more than 1% above the initial lock frequency. The camera will also lose lock if the incoming frequency drops somewhat below 24Hz. Once lock has been lost, the user is presented with an information box and must press a button before control is returned.

A special protection has been included in the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF cameras for customers who are at risk of the sync supply failing accidentally, such as automotive or ballistics applications. If the camera is recording and sync is suddenly lost, the camera will automatically revert to internal sync. The frequency will be the same as the sync speed when lock was first applied, but there will be a delay before the switch over of up to 50ms plus one frame period (worst case). In this case, the warning notice will be displayed, but recording will continue as normal, except for a time slip at the point of sync loss.

In Random Snapshot mode the camera behaves more like a stills camera than a video camera in that the capture of each frame is triggered individually by the sync signal. However the repeat rate of consecutive frames can be up to the normal frame speed limits of the camera. There is no practical lower limit of the repeat rate as it is possible to record only a single frame if desired. It is still possible to input a regularly repeating signal in Random Snapshot mode, in which case a frame will be captured on every defined edge transition. The use of variable frequency sync signals is also possible.

Refer to "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF" for a more detailed explanation of speeds, resolutions and sync modes.

In addition to all other connections



Sync Output: This TTL signal is a 1 microsecond wide active high pulse in which the rising edge signifies the start of the integration period. It is used to synchronise other *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF cameras as mentioned above.

8. Video out connector (yellow)

This connector provides an industry standard PAL or NTSC composite colour video to a video monitor unit. BNC is an industry standard connection for this type of signal, and a BNC composite video cable is provided. The video available from the connector may be switched between NTSC and PAL via the menu system in the CDU.

Composite video signals are designed to be driven into a terminated connector, so care must be taken to ensure that the last piece of equipment in the BNC cable chain is set to terminate with 75 Ohms.

9. Battery charge LED

If power is applied, but the camera is turned off, the battery charge LED will flash orange while charging and show steady orange when charged. When the camera is on or when no battery is fitted, the LED will be off.

10. *i*-CHEQ status indicator

WARNING

- In order to indicate the various operating modes of the camera, the *i*-CHEQ status indicator makes use of flashing light sequences. The maximum flash rate is less than 8Hz, which is not thought to trigger an epileptic fit in the vast majority of sufferers. However, if the user has a history of epilepsy, it is recommended that the risk of triggering a fit is carefully considered before operating this camera.

Located in the Protective Bar / Handle of the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF are three multi-coloured LED indicators. These give the user an indication of the status of the camera. These are useful when the camera is located some distance from the user, but is still visible, or when the camera is not connected to a control device, such as the CDU or a PC.

The *i*-CHEQ status indication is provided by differing colour and motion as listed in the table below. Broadly, green indicates normal camera operation and red indicates an error.

Camera operation	Mode	Status	Pattern
Start-up		Camera software booting	Blue, sweeping left to right
Record	Normal	No trigger received	Green, sweeping left to right
Record	Normal	Trigger received, timeout in progress	Green, alternating left & right
Record	ROC BROC	Waiting for trigger to start burst	Green, sweeping left to right
Record	ROC BROC	Burst recording in progress	Green, alternating left & right
Record	Stopped	Done (end of memory or trigger timeout complete)	All LEDS fixed Green
Error	Error	An internal error has been detected	All LEDs rapidly flashing red simultaneously.
All	Power button	Power button pressed	All LEDs rapidly alternating red / blue simultaneously. After 1 second, right LED extinguishes, after another 1 second centre extinguishes, after another 1 second left fades for 1 second. 4 seconds in total.

11. S-Video connector

This connector transmits video signals to an external video monitor in the S-Video (sometimes called Y/C) format. Due to the nature of the S-Video standard, this signal is slightly higher quality than the more popular composite video signal.

12. Soft Reset

This button will allow access to the data recovery menu if the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera stops responding after being triggered.

13. Compact Flash port

The camera is able to operate with type I and II Compact Flash memory cards. Once the card is inserted it must be pressed firmly in place and may be ejected by pressing the button at the top of the slot. It is not necessary to switch power on and off as the card is inserted and removed, but care must be taken not to remove the card while the Compact Flash card removal warning is visible on the CDU menu screen.

14. Controller Connector

This connector is used to connect the CDU to the camera. It carries power and video from the camera to the CDU and receives button press information from the CDU.

Although this connector conforms to the LVDS industry standard, it is recommended that only cables supplied by Olympus are used and it is imperative that no equipment other than the CDU is attached to this connector.

15. Ethernet activity LED

Close to the Ethernet connector is an LED which indicates the signal standard and the presence of traffic.

Supported standards are Ethernet 10-T, Ethernet 100-T, and Gigabit Ethernet. The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF will automatically switch as appropriate. The Ethernet cable must be connected to an Ethernet switch, although direct connection to a PC / laptop is possible if the crossover cable is used. It is strongly recommended that all the components in the Ethernet network are compatible with Gigabit Ethernet as this will enable the camera's network controller to operate at this higher speed.

16. Ethernet Connector

This connector is a specialised RJ45 connector, comprising a standard RJ45 socket, capable of taking standard RJ45 cable connectors, and an outer ruggedised shell receptacle. The ruggedised shell is similar to an XLR shell and may optionally be fitted over the RJ45 cable to provide protection in harsh environments. The shell may be purchased from standard electronic component suppliers, please see the specification at the end of this manual for part number details.

17. Emergency Backup Battery

The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF includes an emergency backup battery system which will continue to power the camera for up to 45 minutes in the event of power loss. The switch-over is automatic and instantaneous.

When the battery has only 10% charge remaining, the camera will display a warning box. If this is ignored, the camera will shut down at approximately 5% remaining power. The camera is not permitted to run the battery completely empty, because the uncontrolled drop in power could cause corruption of the camera's internally stored data. The time between the warning and the final shutdown is approximately 2 minutes.

A comprehensive description of the battery is given in Section 3.2. In addition, an information page can be found in the CDU menu system at Home ▶ Setup ▶ Config ▶ Battery Status.

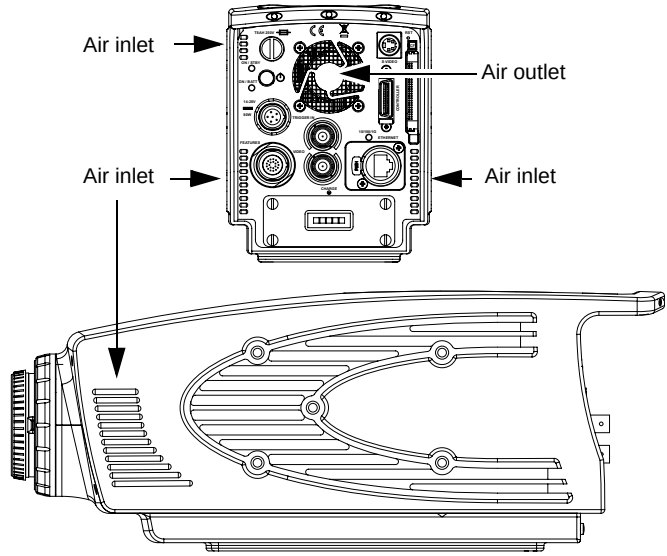
The *i*-SPEED TR is not supplied with an emergency backup battery but is ready to use one. If this is required, the battery may be purchased separately from Olympus.

18. Cooling Holes

Cooling holes are located on the sides of the casework and on the rear panel, these are air inlets while the mesh on the rear panel is an air outlet. The primary reason for including forced air cooling has been to eliminate localised hot spots within the electronics and care should be taken to ensure that the cooling holes are kept clear at all times as described in "Chapter 10 Maintenance".

19. Emergency Shutdown

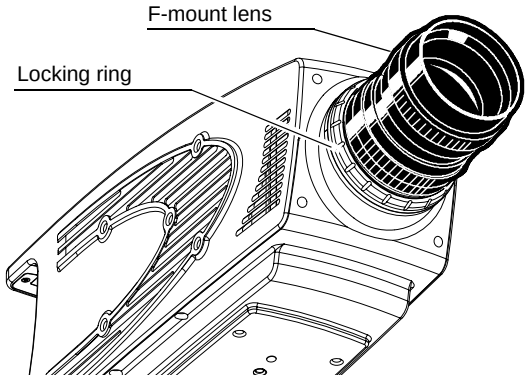
This camera contains sensitive electronic parts which could be damaged by operation at extreme temperatures. To prevent this, the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is equipped with internal temperature sensors. If the internal temperature approaches the safe working limit, the camera will display a warning box. If this is ignored, the camera will automatically shut down. The warning is displayed at 5 degrees Celsius before the limit is reached.



20. Back Focus Control

It is sometimes necessary to adjust the distance between the F-mount face and the image sensor to accommodate lenses from different manufacturers and lenses with different optical tolerances. The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has a back focus assembly located in the front of the unit to permit this adjustment.

To adjust the back focus, attach an F-mount lens into the F-mount in the normal way. Turn the locking ring clockwise (when viewed from the front) to unlock the F-mount ring then rotate the lens to adjust the back focus as required - a series of 'click' positions will be felt. When complete, the adjustment should be left in one of these 'click' positions and the locking ring rotated anticlockwise to lock the F-mount ring in position.



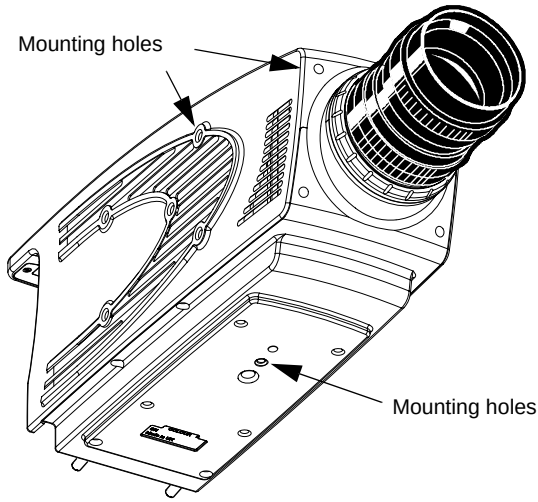
As a guide, the correct setting of back focus is obtained by pointing the camera at an object at a known distance from the lens, preferably an “infinite” distance. The scale on the lens is then used to set the focus ring to this distance. The back focus is then adjusted to obtain the best image.

21. Tripod / lens/ accessory mounting

The base and each side of the camera is fitted with five standard 1/4” BSW thread mounting holes to a depth of 8mm. The base also has a 3/8" BSW thread fixing hole to a depth of 8mm and an anti-rotation indent for those tripod adaptors with this feature.It is recommended that the central hole is used for mounting the camera to a tripod and the other holes may then be used to mount light-weight accessories to the camera.

Four 1/4" BSW thread fixing holes on the front of the camera permit attachment of fixtures customised for specific lenses.

In high-G applications it is recommended that the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS or *i*-SPEED DF is mounted using all five 1/4" base fixing points.



22. Protective Glass

The image sensor is located at the front of the camera inside the F-mount aperture. A protective glass is fitted in front of the sensor to shield the sensor from dust and damage. It is recommended that the glass is kept clean as detailed in "Chapter 10 Maintenance".

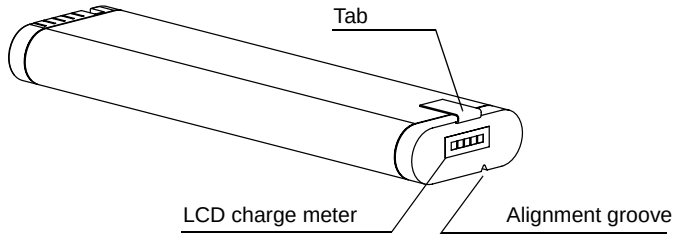
23. Battery Clock

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF contains a battery powered clock. This is used to keep track of the time and date while the camera is switched off. The battery is a non-replaceable silver oxide cell which should last for approximately 5 years. In the event of battery failure, default values will be used at each switch-on.

3.2 Emergency backup battery

WARNING

- The emergency backup battery is a customised Lithium Ion unit and should not be replaced with any other battery, even if it looks the same and is the same size. It is a high energy unit and must be treated with care.
- The emergency backup battery should only be charged in the camera or with a charger specifically recommended by Olympus.
- The emergency backup battery must never be:
  - short circuited
  - punctured, dismantled, physically shocked or deformed
  - heated above 60°C
  - cooled below -20°C
  - disposed of in fire
  - immersed in liquid
- The emergency backup battery supplied with non high-G rated cameras may not suitable for use in high-G applications. Ensure that only a high-G rated battery is used in a high-G application and that the battery door screws are appropriately tightened. The non high-G rated battery is labelled as Ni2040ED24 while the high-G rated battery is labelled as Ni2040ED.



1. LCD charge meter

The LCD charge meter displays the charge status of the battery.

2. Alignment groove

Ensures correct battery orientation.

3. Tab

An aid to battery removal. The tab should be stowed in the pocket provided on the rear of the camera to prevent the charge meter from being obscured.

Functional description

When fully charged, the emergency backup battery will continue to power the camera for up to 45 minutes in the event of power loss. The switch-over is automatic and instantaneous.

There are several alerts to the user, there will be a change in the power indicators on the back of the camera, as the green On DC light extinguishes and the red On Batt light illuminates. The power meter on the CDU, which normally shows a battery and a power plug will display only a battery. As the battery discharges, the battery meter icon will empty and the CDU will display a warning when battery capacity is almost exhausted.

A completely flat battery will be fully charged by the camera in three hours. The charger function is indicated by an LED on the rear panel near the battery. If power is applied, but the camera is turned off, the LED will flash orange while charging and show steady orange when charged. When the camera is on or when no battery is fitted, the LED will be off.

Emergency shutdown

When the battery has only 10% charge remaining, the camera will display a warning box. If this is ignored, the camera will shut down at approximately 5% remaining power. The camera is not permitted to run the battery completely empty, because the uncontrolled drop in power could cause corruption of the camera's internally stored data. The time between the warning and the final shutdown is approximately 2 minutes.

Calibration

As the battery ages, the charge capacity will decrease, this has two effects. Firstly, the power gauge becomes less accurate. When a 10% inaccuracy is detected, the camera will warn that a re-calibration is required. The battery may also be calibrated by an external charger supplied by Olympus, or the battery may be returned to an Olympus Service Centre for calibration. Failure to calibrate will not harm the battery or camera, it will however result in a less accurate power gauge.

End of life

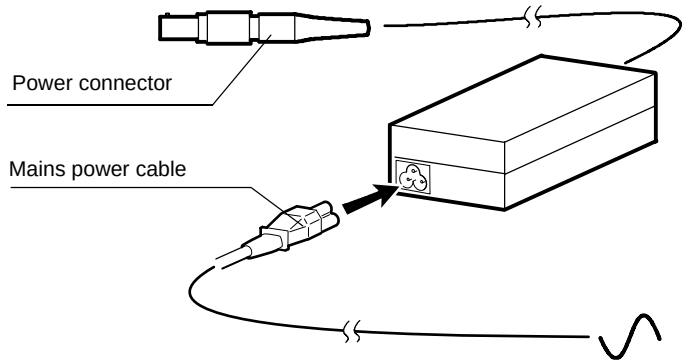
When the battery has aged sufficiently and much of its capacity has been lost, it will no longer be suitable for use as a backup supply. In this case, the battery should be replaced as described in "Chapter 10 Maintenance", a warning on the CDU will alert the user at this time.

At end of life, the battery must be disposed of in accordance with local regulations or returned to an Olympus Service Centre for correct disposal.

Battery information

A battery information page is available from the CDU menu system accessed from Home ▶ Setup ▶ Config ▶ Battery Status.

3.3 Power supply/mains cable



1. ON-OFF switch

The 19VDC Power supply is supplied with the appropriate AC mains power cable. The power supply unit MUST be earthed and it is recommended that the mains power cable supplied is used to maintain standards compliance.

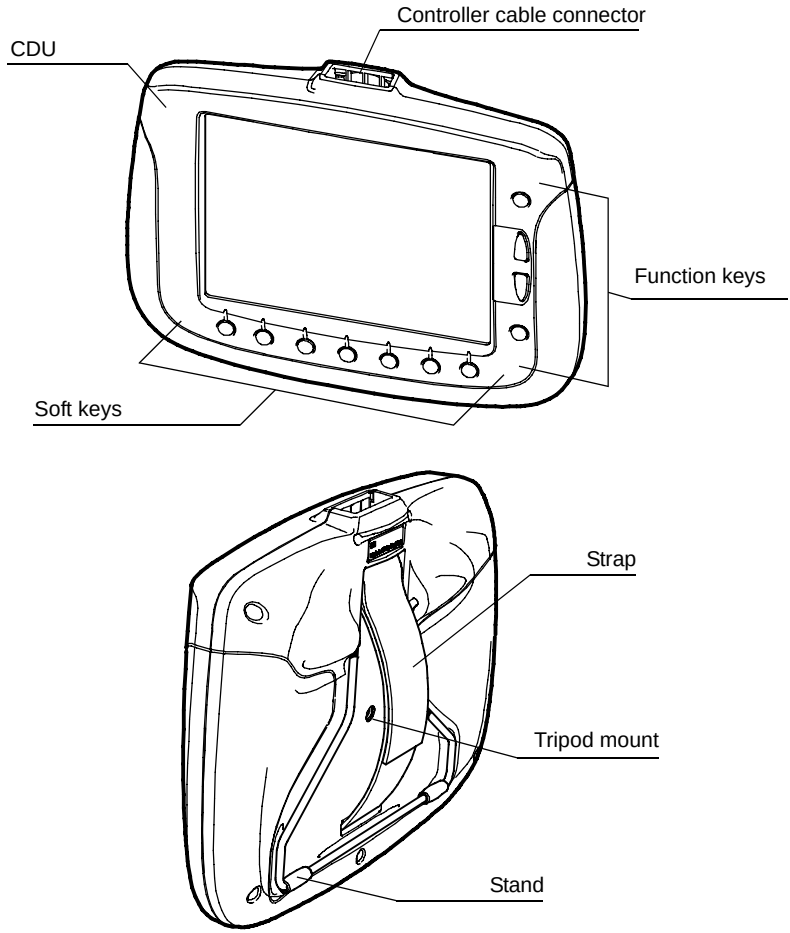
2. Power connector

Connects to the 'power' socket of the camera and provides power to the camera and its controller units

CAUTION

- The user must ensure that only the power supply unit supplied with the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is used and that this unit is only used to power the camera.
- The memory in the camera will be erased if power to it is lost. In order to prevent this, the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF contains an emergency backup battery system which will automatically power the camera in the event of DC power failure.The user must ensure that this battery is sufficiently charged before exposing the camera to a situation in which DC power may be accidentally lost.
- This power supply must be connected to a power outlet which is correctly earthed.
- The power supply must be accessible at all times during use so that it can be easily disconnected from the mains power supply in the event of an emergency.
- This power supply unit is not high-G rated.

3.4 Controller Display Unit (CDU)



CAUTION

- The CDU can be detached and reattached without switching the camera off.
- The CDU is not high-G rated.

1. CDU

The CDU displays the image from the camera in real-time and permits the most flexible use of the camera, by using a series of buttons around the outside of the screen. The CDU is connected to the camera's Controller connector via a 3m controller cable (a 10m cable is available as an optional accessory). The CDU takes power and video from the camera and requires no batteries or further connections.

The camera is able to recognise the presence of the CDU and operates a specialised menu system.

LCD Panel, Viewing Angle: At the time of design and writing this manual, the LCD panel used in the CDU is the best available LCD panel of this size and resolution. Even this market leading panel, however, has a restricted viewing angle in the vertical direction and the user is advised to experiment with the CDU to find the optimum angle at which to view the image.

Protective Screen: Although the CDU LCD screen is protected by a tough plastic sheet, it is still recommended that care is exercised when handling this unit. It is also important to keep this screen clean to preserve its anti-glare properties and this is detailed in "Chapter 10 Maintenance".

2. Soft keys

The bottom seven buttons on the CDU are used as "soft keys", that is the function of each button is dependent on the text written above it on the screen.

3. Function keys

The four buttons on the right hand side of the CDU are dedicated function buttons, these are Text, Back, Up and Down. The menu system has been specially constructed to take maximum advantage of this layout.

4. Stand

The CDU is equipped with a stand which may be set to a number of 'click-stop' positions to allow standing on a flat surface at various angles or hanging from a convenient hook. The stand may also be folded flat for storage or when the strap is used.

5. Strap

The back of CDU has an adjustable strap which may be used to allow the unit to be conveniently held with a single hand.

6. Tripod Mount

The CDU contains a tripod mounting hole with the industry standard thread and is located under the strap.

CAUTION

The CDU must not be connected to any equipment other than the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera, otherwise equipment damage will occur.

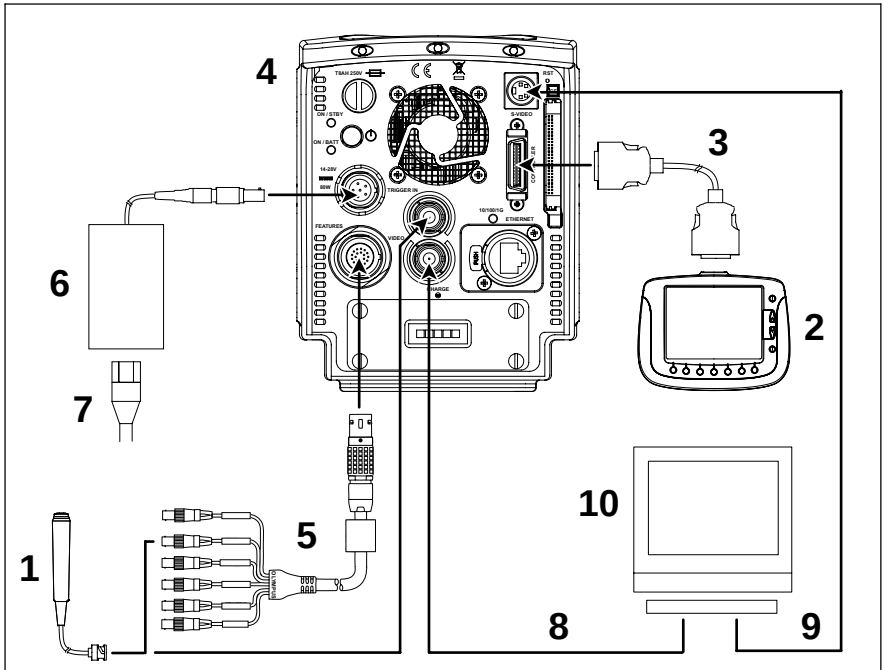
NOTE

To maintain standards compliance, it is recommended that only cables supplied by Olympus are used.

Chapter 4 System Connection

The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera system can be configured for use with the Controller display Unit (CDU) or PC/Laptop. Refer to the appropriate connection diagram for system connection.

4.1 Controller Display Unit (CDU)

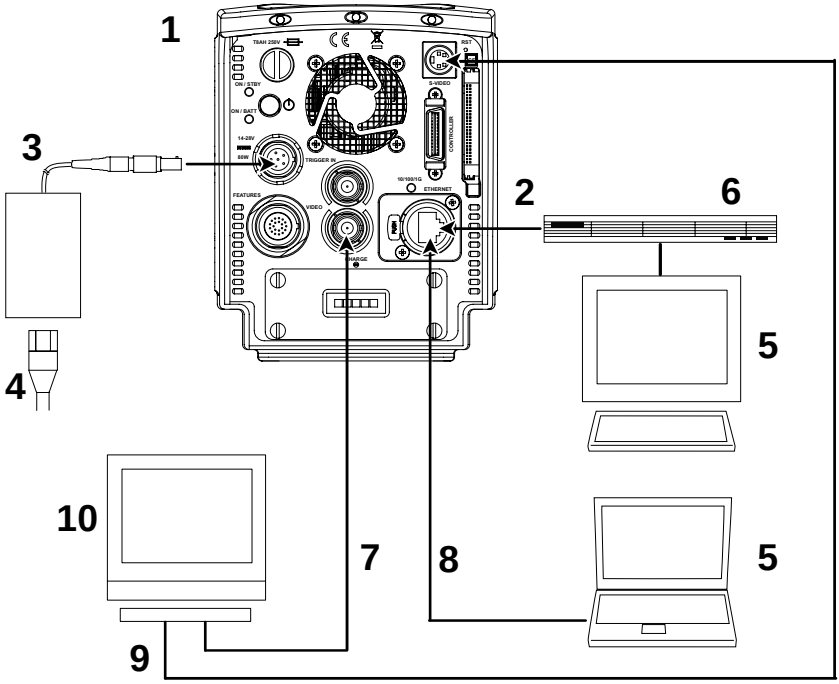


Key

1	Trigger switch	6	Power supply unit
2	Camera Display Unit (CDU)	7	Mains power cable
3	Controller cable	8	Composite video BNC cable
4	Camera	9	S-video cable
5	Feature connector cable	10	Optional TV monitor

* Not all items shown are supplied in the standard set (refer to Page 8).

4.2 PC/Laptop connection



Key

1	Camera	6	Network switch
2	Ethernet cable	7	Composite video BNC cable
3	Power supply unit	8	Ethernet crossover cable (grey)
4	Mains power cable	9	S-video cable
5	Laptop or PC	10	Optional TV monitor

* Not all items shown are supplied in the standard set (refer to Page 8).

Chapter 5 Getting Started

This section provides a functional description followed by the basic steps required to start using the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera system.

5.1 Functional description

Assuming an F-mount lens has been fitted and the system has been connected as described in Chapter 4, the typical sequence of events is as follows.

The frame speed and shutter settings are chosen, the lighting and lens are adjusted appropriately and the camera is placed in record mode.

The camera then takes video at high frame rates and stores it in the built-in memory. This memory is configured in a circle so that, once the memory is full, each new frame replaces the oldest stored frame. In this way, the camera keeps a rolling history of the scene it views and this process can continue indefinitely. Once the desired event has occurred, the camera is stopped or triggered.

During the entire set-up and record process, the CDU and any monitor attached will display the live image in full colour and in real time.

Once the required video clip is stored in memory, it may be viewed by using the player function. In this mode, video may be played forwards or backwards at a range of speeds. A convenient bookmark system is provided for easy navigation between sections of interest.

The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has an internal battery, so that the contents of the memory are protected in the event of main power loss. However, the memory in the camera will be erased without power, so if it is necessary to preserve the captured video after power off, it may be recorded onto a Compact Flash memory card, which is inserted into the card slot provided. High speed video clips generally contain a large amount of “dead time” and a relatively small amount of useful motion, in recognition of this, the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has a clip select function which allows a precise choice of the video to be saved.

Further to these functions, it is sometimes necessary to measure a feature of the recorded motion and the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF contains an advanced measurement suite.

5.2 Use with the CDU

This section describes the basic steps required to start using the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera system with the CDU. Additional information regarding functionality of the CDU can be found in Chapter 6 and Chapter 7.

Operation of the CDU menus (Figure 5.1)

To navigate through the menu system, the button nearest the desired selection is pressed.

When a control is selected, the desired value may be chosen by using the ▲ and ▼ buttons on the right hand side of the screen. Repeatedly pressing or to press and hold the control button will cycle through the available values. The current value is displayed above the control button and also next to the ▲▼ buttons.

To return to a higher menu, the Back button is pressed. If there is a requirement for a text free screen, the Text button is used to cycle the on-screen text through full, time/date only and off options.

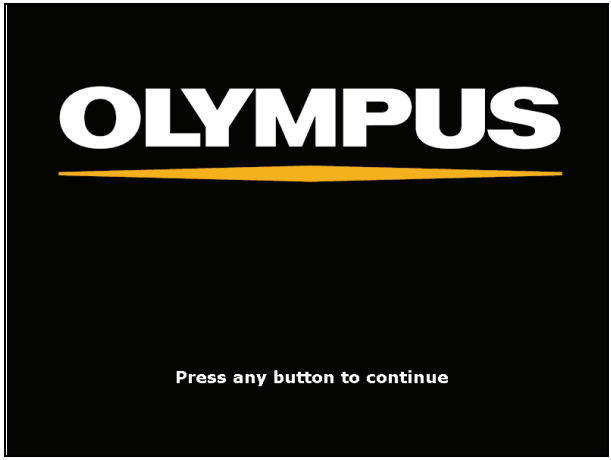
Figure 5.1

CAUTION The CDU is not high-G rated.

1. Connect the system as described in Chapter 4 then connect the mains power cable to a suitable AC wall outlet and switch the power ON.
2. Press the power button on the rear of the camera. When the camera has powered up, the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF splash screen is displayed on the CDU.

NOTE

The splash screen displays the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF legend and the camera software version.

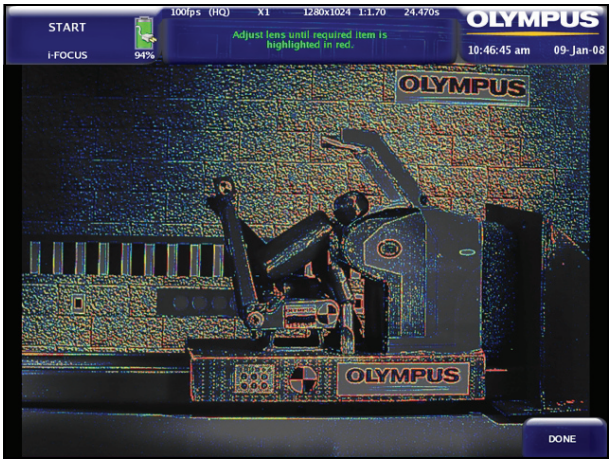


3. Press any button to continue, the Home menu and a live video image is displayed on the CDU.

4. Depress the Start button to enter the Start menu, then depress the Speed and Shutter buttons to select the desired frame speed and shutter speed.

5. Adjust the lens focus and iris as required to achieve a sharp, bright image.

   To assist in the focussing process, the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF incorporates a feature called *i*-FOCUS. This image processing function analyses the image from the sensor, detects the state of focus and presents the user with a specially modified view of the image as shown below.



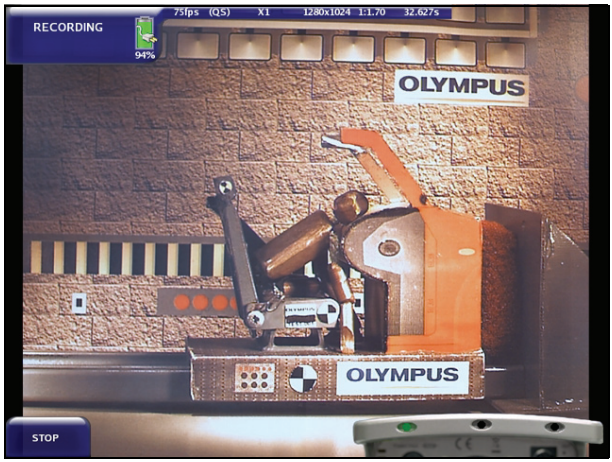
The basic picture is displayed without colour and with reduced brightness. Items in sharp focus are then highlighted in red, less focussed items are shown in yellow, then green, then blue. Out-of focus items are not highlighted.

With this feature, the user can easily locate the area of interest in the image and then adjust the focus ring of the lens to achieve the maximum possible focus in these areas, or achieve a compromise of focus in multiple areas of interest.

6. Depress the Record button, the camera records video into its circular buffer until the Stop button is depressed or the trigger button is pressed.

NOTE

- If the trigger is used, recording will stop after a delay. This delay depends on memory size, the trigger position setting and frame speed.
- When using the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS or *i*-SPEED DF for high-G tests, disconnect the CDU from the camera. When recording has stopped, reconnect the CDU.



When recording has stopped, whether by trigger or STOP button, the camera will present the Playback menu. Press the Player button to enter Player menu and display the first recorded image in the memory.

7. Player controls are: Bookmark, jump back (to bookmark), play backwards, Clip select, play forwards, jump forward (to bookmark), Loop. Pressing and holding the play forwards or play backwards buttons will provide fast forward and fast rewind functions.

The Bookmark control is used to set bookmarks at points of interest and are displayed as yellow vertical lines in the progress bar at the top of the screen. When the Trigger is used, an automatic bookmark is displayed as a Red vertical line.

8. Use the up/down buttons on the right hand side of the CDU to adjust playback speed.

9. If the video clip is to be saved, insert a Compact Flash card into the Compact Flash slot in the camera, then press Clip select.

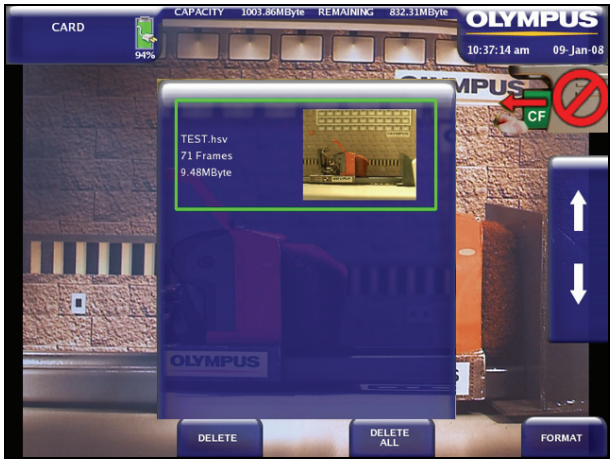
10. Use the control buttons to move to the start frame and press Clip start, move to end frame and press Clip end.

Frame and memory status is displayed top right.

NOTE

Note that Clip select will not be available until a card is inserted.

11. To save the selected clip, depress Save or to access image quality or video processing options, select Settings, the Save option is also available from this screen.
12. Enter the filename using the options on screen and press OK to save, the Card menu is displayed.



13. Depress BACK as required to return to the Home menu.

CAUTION

Do not remove the Compact Flash card while the Compact Flash card removal warning is visible on the CDU menu screen.

5.3 Use with a PC/Laptop

For detailed use with a PC/Laptop, refer to the instruction manual provided with the software. The i-SPEED TR, 3, FS, DS is supplied with a factory set IP address of 192.168.0.54 and a subnet mask of 255.255.255.0. The user may change the address and the subnet mask.

Chapter 6 Embedded Software Reference (CDU) *i*-SPEED TR

Introduction

This reference section describes the *i*-SPEED TR embedded software and its user interface from the viewpoint of the CDU. In this section, items which are printed *like this* signify the name of a sub menu, controls are described whenever they appear in a menu.

Operation of the CDU menus

To navigate through the menu system, the button nearest the desired selection is pressed.

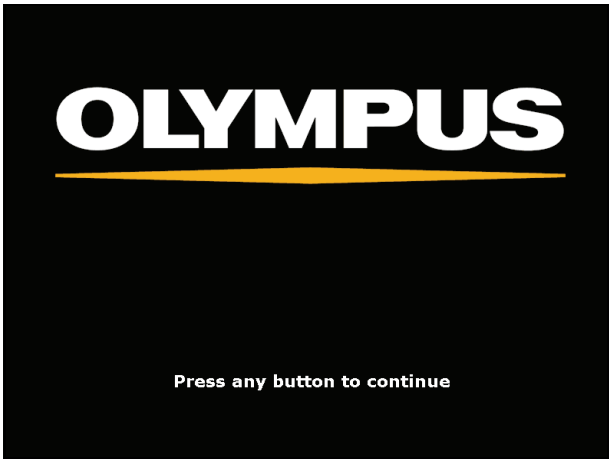
When a control is selected, the desired value may be chosen by using the ▲ and ▼ buttons on the right hand side of the screen. Repeatedly pressing or to press and hold the control button will cycle through the available values. The current value is displayed above the control button and also next to the ▲▼ buttons.

To return to a higher menu, the Back button is pressed. If there is a requirement for a text free screen, the Text button is used to cycle the on-screen text through full, time/date only and off options.

6.1 Menu screens

1. Splash screen

   This screen is displayed while the camera starts up and configures the internal software, the software version number is displayed in the bottom right hand corner. To exit this screen, the user must press any button on the CDU.



2. Home menu

This is the top level or home screen of the menu system. It may be accessed by pressing the Back button repeatedly from any position in the menu system.

Options: Start Setup User Settings Playback Card Power Off

When the user enters the Home, Start or Picture menu, a luminance histogram window is displayed at the top of the CDU (see image above), which provides a real-time analysis of the image displayed on the CDU. The graph indicates the quantity of pixels in the image at each of the available brightnesses, with black on the left side and white on the right side. The graph may be understood as a pixel counter, the higher the graph at one point, the more pixels have been counted at that brightness. For example, if there are a lot of dark pixels, the graph will be high on the left and low on the right.

Interpretation of the graph is an acquired skill, but it is an extremely powerful tool. In general, if the graph is highest in the left area and flat at zero in the right, the picture is too dim. If the graph is highest in the right area and low in the left, the picture is too bright. A well balanced picture will have most parts of the graph somewhere in the middle.

Please note that if all the pixels were at the same brightness, the entire graph would be zero, apart from one very tall thin spike at that brightness. Naturally, the window is not tall enough to accommodate the height of this spike, so the graph is clipped to the size of the window.

❍ Power off

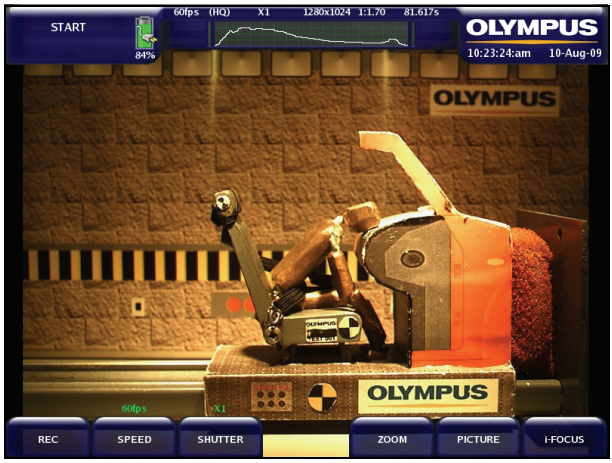
This control is used to Power down the camera. This function is the preferred method of turning the camera off. Protection against accident is provided by a confirmation box. This function is necessary, because attempting to turn the camera off by removing DC power will fail, since the camera will automatically switch to battery. The power button on the rear panel is also able to turn off the camera, but includes a 4 second timeout to prevent accidental switch-off.

3. Start menu

This menu provides rapid access to the most commonly used functions.

Access: Home ▸ Start

Options: Rec Speed Shutter Zoom Picture i-Focus



❍ Speed Control

This control allows the user to set the frame speed of the camera. The lowest speed available is 1 frame per second and the maximum speed is 10,000fps.

As described in "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF", the user will normally need to open the iris of the lens and/or add more light as the speed is increased. Further, the image will appear to zoom in as the frame speed is increased above 2,000 frames per second.

❍ Shutter Control

It is sometimes desirable to reduce the time during which the sensor gathers light (called "exposure time", "integration time" or "shutter time") in order to reduce motion blur and "freeze" the motion in each frame. The default shutter time is equal to the frame time, but this may be reduced by this control. The shutter time is measured as the ratio between frame time and shutter time, e.g. x10 means that the shutter is open for 1/10 of the frame period. The shutter period may range from the frame period (x1) to a ratio that corresponds to a minimum of 2.16μs.

Note that the image sensor requires time to reset ready to capture each frame, so x1 is an approximation and that at the highest speeds this may not be available.

Some users prefer to operate the shutter in terms of time, so that the shutter period does not change when the frame speed is changed. The *i*-SPEED TR shutter control may be switched to this mode in Home ▶ Setup ▶ Control Mode ▶ Shutter Mode.

Note that if a long shutter time is chosen and the frame speed is then increased, the long shutter time will not be possible. Under these circumstances the *i*-SPEED TR will clip the shutter time, but if a lower frame speed is selected, the *i*-SPEED TR will not move the shutter time back again.

The user should note that as the shutter ratio is increased or shutter time is decreased, the camera will require more light.

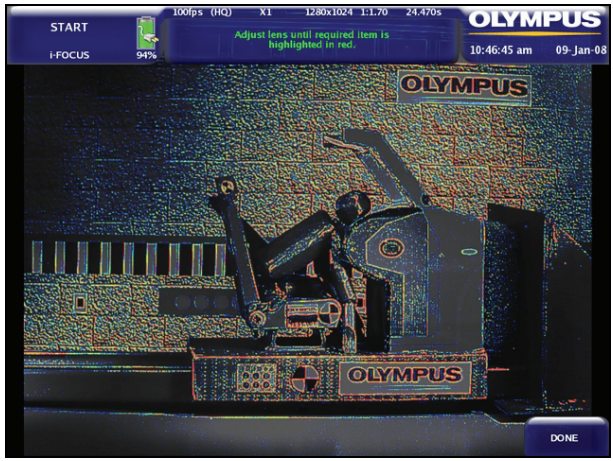
4. *i*-FOCUS

This function enables the user to focus the camera more accurately, especially when using a display with less resolution than the camera. i-FOCUS presents a basic image without colour and with reduced brightness, but with focussed areas highlighted in red. Less well focussed areas are coloured yellow, then green, then blue. Unfocussed areas are not coloured.

With this feature, the user can easily locate the area of interest in the image and then adjust the focus ring of the lens to achieve the maximum possible focus in these areas, or achieve a compromise of focus in multiple areas of interest.

Access: Home ▶ Start ▶ *i*-Focus

Options: Done



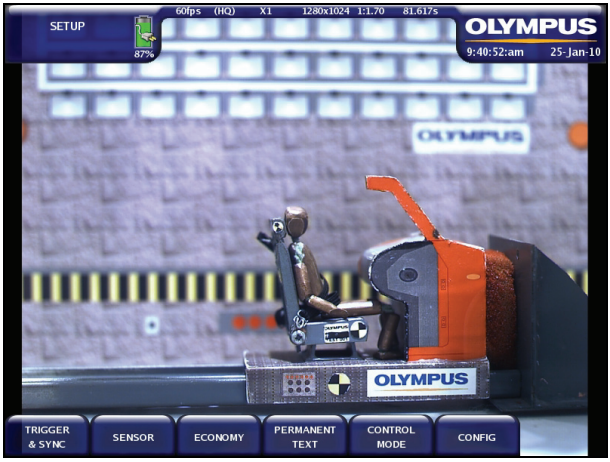
❍ **Done**

Returns the user to the previous screen.

5. Setup menu

Access: Home ▸ Setup

Options: *Trigger & Sync* *Sensor* *Economy* *Control Mode* *Config*



6. User settings menu

The Olympus *i*-SPEED TR has the ability to save and recall most of the settings applied by the user. These may be saved / recalled from the camera's internal memory.

Access: Home ▸ User Settings

Options: Load default Load last Load New cam Save Delete

- **Load default**

  This function sets the camera to a sensible configuration. It is intended as a rescue function when a user has changed more settings than he can remember.

- **Load last**

  At power-off, the camera stores the settings in internal memory and these may be recalled after a new switch-on.

- **Load**

  The user may load settings from the camera's internal memory.

- **New CAM**

  This option allows the user to create a new name in one of the camera's save spaces.

- **Save**

  The user may save the current settings in the camera's internal memory. The destination of the save is indicated by the highlight in the list of names at the side of the CDU. The camera has a fixed number of save spaces.

- **Delete**

  The user may delete settings from the camera's internal memory. The settings to be deleted are indicated by the highlight in the list of names at the side of the CDU.

  A status bar at the top of the screen shows the number of slots free in internal memory.

7. Playback menu

This menu makes available all the items which relate to the playback view systems of the camera. The playback menu is not available until a recording has been made.

Access: Home ▶ Playback

Options: Player Picture Zoom Measure

- Automatically appears after recording has stopped and displays the playback image.

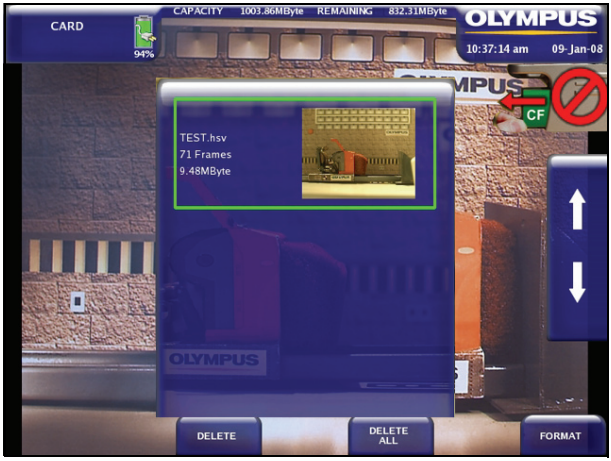
8. Card menu

This menu makes available the items which relate to the management of the removable Compact Flash card. Before a Compact Flash card is accessed, the camera will check the card for any file system corruption that could cause errors. If any error is found the user will be notified and asked if they wish to format the card to attempt to fix the problem.

The screen displays a thumbnail of each video file on the card and one of these will be highlighted by a colour border.

Access: Home ▸ Card

Options: Delete Delete All Format



- **Delete**

  This control is used to delete the selected file from the card. The user is protected from error by a confirmation question.

- **Delete All**

  This control is used to delete all of the video and image files from the card. The user is protected from error by a confirmation question. All the contents of the 'movie' and 'image' folders on the card will be deleted. Any other files stored in other folders on the card will not be deleted.

- **Format**

  The user is able to format the card. This will delete all of the files on the card and also prepare a new card for its first use in the camera. The user is protected from error by a confirmation question.

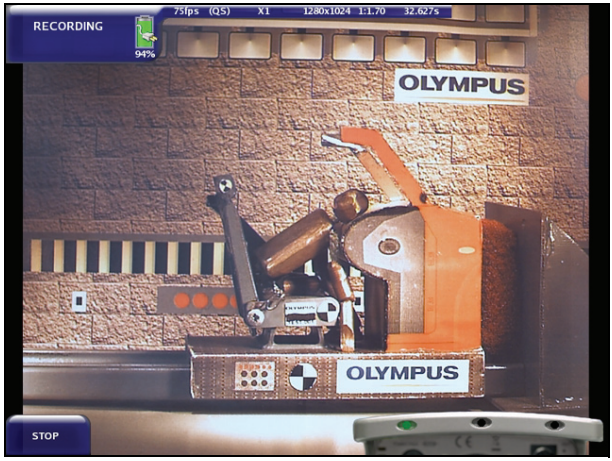
9. Recording menu

When the recording screen is displayed, the Olympus *i*-SPEED TR is recording video into its circular buffer. The record action is confirmed by the presence of an animated camera on-screen and the LED indicators on the handle - see description and table below.

When recording has stopped, whether by the trigger or the STOP button on the CDU, the camera will automatically present the Playback menu and thereby display the first recorded image in the memory.

Access: Home ▶ Start ▶ Record

Options: Stop



Located in the Protective Bar / Handle of the Olympus *i*-SPEED TR are three multi-coloured LED indicators. These give the user an indication of the status of the camera. These are useful when the camera is located some distance from the user, but is still visible, or when the camera is not connected to a control device, such as the CDU or a PC.

The *i*-CHEQ status indication is provided by differing colour and motion as listed in the table below.

Camera operation	Mode	Status	Pattern
Start-up		Camera software booting	Blue, sweeping left to right
Record	Normal	No trigger received	Green, sweeping left to right
Record	Normal	Trigger received, timeout in progress	Green, alternating left & right
Record	ROC BROC	Waiting for trigger to start burst	Green, sweeping left to right
Record	ROC BROC	Burst recording in progress	Green, alternating left & right
Record	Stopped	Done (end of memory or trigger timeout complete)	All LEDS fixed Green
Error	Error	An internal error has been detected	All LEDs rapidly flashing red simultaneously.
All	Power button	Power button pressed	All LEDs rapidly alternating red / blue simultaneously. After 1 second, right LED extinguishes, after another 1 second centre extinguishes, after another 1 second left fades for 1 second. 4 seconds in total.

❍ STOP Control

This control will cause the camera to stop recording immediately, regardless of the setting of the trigger position.

10. Picture menu

This menu enables the user to apply image processing to the live picture on the CDU screen to improve the visibility of details in the image. Any processing applied via this menu will not be applied to the images saved onto the Compact Flash card with the exception of the White Balance. If the Ethernet connection is invoked subsequent to the application of image processing, the images transferred to the PC will include this processing.

NOTE

Some of the picture menu options are not available for a mono camera.

Access: Home ▶ Start ▶ Picture
Home ▶ Playback ▶ Picture

Options: *Brightness* *Contrast* *White Balance* Reset All

❍ Reset All Control

This control resets the Brightness and Contrast controls to their default values.

11. Brightness menu

The controls in this menu permit the user to alter the “brightness” of the image. This control mimics the operation of the ”brightness” control in CRT video monitors by altering the black level of the image. Although this alters the appearance of the image, it is often helpful in making detail hidden in dark areas become more visible. Since a video image is made of the primary optical colours, red, green and blue, these colours may be individually adjusted, or all may be adjusted together.

Access: Home ▶ Start ▶ Picture ▶ Brightness
Home ▶ Playback ▶ Picture ▶ Brightness

Options: All Red Green Blue Reset

- **All Control**

  Permits all colours to be adjusted together.

- **Red/Green/Blue Controls**

  Permits individual colour adjustment.

  NOTE These controls are not available for a mono camera.

- **Reset Control**

  Resets all adjustments to original values.

12. Contrast menu

The controls in this menu permit the user to alter the “contrast” of the image. This control mimics the operation of the ”contrast” control in CRT video monitors by linearly adding gain to the image. This is often helpful in making obscure detail become more visible and compensating for poor or harsh lighting conditions. Since a video image is made of the primary optical colours, red, green and blue, these colours may be individually adjusted, or all may be adjusted together. Individual adjustment is also useful for altering the colour balance of an image, to compensate for (or imitate) coloured ambient illumination.

Access: Home ▶ Start ▶ Picture ▶ Contrast
Home ▶ Playback ▶ Picture ▶ Contrast

Options: All Red Green Blue Reset

- **All Control**

  Permits all colours to be adjusted together.

- **Red/Green/Blue Controls**

  Permits individual colour adjustment.

  NOTE These controls are not available for a mono camera.

- **Reset Control**

  Resets all adjustments to original values.

13. White balance menu

This menu enables the user to set the correct white balance depending on the lighting used.

NOTE

This function is not available for a mono camera.

Access: Home ▶ Start ▶ Picture ▶ White balance
Home ▶ Playback ▶ Picture ▶ White balance

Options: Mode White balance set

❍ Mode Control

Several preset white balance settings are provided, based on light source technologies found in the Olympus range of industrial light sources.

❍ White balance set Control

Performs an automatic white balance process. Before pressing this control, the user must place a pure white reference (sheet of paper etc.) in front of the camera, completely filling the field of view. This must not be removed until the white balance is complete. An on screen message shows the status of the white balance process.

Please refer to "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF" for a further description.

The control is only available if the white balance mode is set to automatic.

NOTE

Once this is set, the white balance setting is stored in the camera's internal memory.

14. Trigger and Sync menu

This menu relates to trigger modes and settings. It would be of benefit to read "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF" for further descriptions on several of the terms and phrases used in this section.

Access: Home ▶ Setup ▶ Trigger & Sync

Options: Trigger Mode *ROC/BROC setup* Trigger event *Trigger position* *Sync*

- **Trigger Mode Control**

  This control is used to change the camera into one of the following modes of operation:

  Normal, ROC (Record On Command), BROC (Burst Record On Command).

- **Trigger Edge Control**

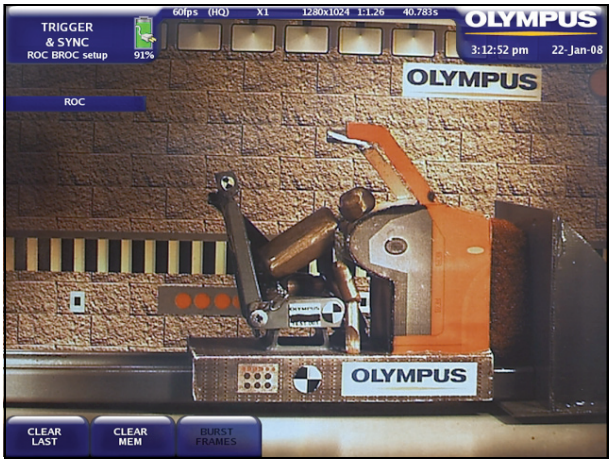
  This control sets the trigger detection system to wait for a rising edge or a falling edge on the trigger input connection.

15. ROC/BROC setup

This menu relates to trigger modes and settings. It would be of benefit to read "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF" for further descriptions on several of the terms and phrases used in this section.

Access: Home ▶ Setup ▶ Trigger & Sync ▶ ROC/BROC setup

Options: Clear last Clear mem Burst frames



- **Clear Last Control**

  Pressing this control deletes the last burst recorded in ROC or BROC mode. This control is not available in normal trigger mode, or if no burst is available for deletion.

- **Clear Mem Control**

  Pressing this control deletes the entire contents of the memory, permitting further use of the ROC or BROC modes. This control is not available in normal trigger mode, or if no burst is available for deletion.

- **Burst Frames Control**

  This sets the length of the bursts recorded when the trigger is activated in BROC mode.This control is not available in normal trigger or ROC modes.

16. Trigger Position menu

This control sets the length of the trigger delay, so that the trigger point will appear at a user-settable position in the recorded video clip. With the trigger position at 0%, the trigger delay is equal to the length of the circular buffer and the trigger point will appear at the beginning of the video clip. With the trigger position at 100%, the trigger counter is set to zero and the recording will stop immediately the trigger is activated, thus the trigger point will appear at the end of the video clip.

NOTE

This control is not available in ROC and BROC modes.

Access: Home ▶ Setup ▶ Trigger & Sync ▶ Trigger position

Options: Start Mid End ◀10% ▶10% ◀ Frames ▶ Frames

❍ Start, Mid, End Controls

These controls allow the user to set the trigger position to the start, middle, or end point of the recording. If End is selected, the recording will stop immediately a trigger is received, so that the trigger point is the last frame of the resultant clip

- **10% Controls**

  These controls allow the user to set the trigger position in steps of one tenth of the length of the cameras memory.

- **Frames Controls**

  These controls allow the user to set the trigger position to the desired frame number with complete accuracy. When setting to an absolute frame number, the user is advised to use the 10% controls first in order to save time.

17. Sync

The sync menu enables the user to configure the synchronisation options for ensuring that frames are synchronised to external signals.

Access: Home ▶ Setup ▶ Trigger & Sync ▶ Sync

Options: Sync edge Sync mode

❍ Sync Edge Control

This control sets the sync detection system to wait for a rising edge or a falling edge on the sync input connection.

18. Sensor

The sensor menu enables the user to enhance the image in poor light conditions.

Access: Home ▶ Setup ▶ Sensor

Options: Enhanced sensitivity

❍ Enhanced Sensitivity

This option may be used to add 2x gain into the analogue electronics in the Image Acquisition system at the front of the camera.

19. Economy

Many high speed events are primarily horizontal or vertical in nature and so the edges of the screen often contain no useful video information. It is also sometimes desired to have a longer record time than that given by the available memory option. This control addresses both of these issues by causing the camera to use a central subsection of the sensor, rather than the maximum available area. This has the effect of reducing the number of pixels recorded in each frame and so effectively increasing the record time available.

Where possible, the zoom engine will return the image to full screen.

Access: Home ▶ Setup ▶ Economy

Options: Mode

❍ **Mode**

Enables the user to select from a range of preset economy modes.

20. Control Mode menu

Access: Home ▸ Setup ▸ Control Mode

Options: Shutter Mode

❍ Shutter mode

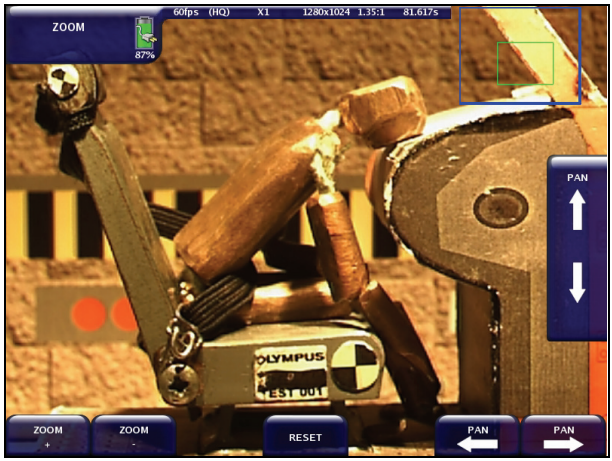
The shutter setting may be controlled in microseconds, selected by this setting. This will also apply if non-standard speeds are enforced by the external sync signal.

21. Zoom / Pan menu

This menu provides access to the controls of the built-in zoom engine.

Access: Home ▸ Start ▸ Zoom
Home ▸ Playback ▸ Zoom

Options: Zoom+ Zoom- Reset Pan Left Pan Right
Pan Up Pan Down



❍ Zoom Control

The Olympus *i*-SPEED TR camera has a built-in zoom engine which can electronically minify or magnify the video image. The user may adjust the level of zoom using the zoom control in this menu.

It should be noted that the zoom engine is automatically operated to fit the image from the sensor in the CDU screen. Minification is used when the sensor resolution exceeds the CDU resolution. For example, the CDU has a resolution of 800 x 600, but the sensor has a resolution of 1280 x 1024 at speeds up to 2,000fps. In this case, the minification engine will zoom out by 1:1.7 (also written as 0.586:1). When high frame rates result in the active area of the sensor being reduced below the CDU resolution or when the “square” economy mode is selected, the zoom engine will magnify the image to fit the CDU. In these circumstances, the user may still zoom further into the zoomed image, but there is a limit to the total zoom that may be employed.

- **Reset Control**

  Resets any pan and zoom adjustments to their default values.

- **Pan Control**

  For the convenience of the user, pan controls are also provided. These are individually disabled when the limit of the pan in a given direction is reached, and all are disabled when the zoom engine is turned off (1:1).

22. Player menu

The player screen allows the user to play back and interact with the video stored in the circular buffer memory.

Access: Home ▸ Playback ▸ Player

NOTE

Also accessed from the measurement system

Options: Bookmark I◀ ◀ Clip select ▶ ▶I Loop

❍ Bookmark Control

This control is used to set bookmarks at points of interest. Pressing the button when already on a marked frame will remove the bookmark. Bookmarks are displayed in the progress bar at the top of the screen. For the convenience of the user, the trigger frame is automatically given its own bookmark, and this is coloured differently for clarity.

❍ Player Controls

The controls should be familiar to most users: jump back, play backwards, play forwards, jump forward. Clip select toggles to ■ (Stop) when the ◀ or ▶ buttons are pressed. Pressing and holding the play forwards or play backwards buttons will provide fast forward and fast rewind functions

The jump controls will cause the player to immediately move either to the next bookmark or to the beginning/end of the memory.

The speed of playback is controlled by the ▲ ▼ buttons on the right hand side of the CDU. The chosen playback speed is indicated in a label next to these buttons.

❍ Clip select

The Player controls are used to locate the start and end of the desired video clip and the Clip Start and Clip End controls on the Clip select menu are used to mark the chosen frames.

❍ Loop

This control loops the video clip until the stop button is pressed. If the loop control is pressed when the frame marker is between or at a bookmark, only the bookmark section will be looped.

❍ On Screen Information

A progress bar is provided at the top of the screen to indicate the relative position within the circular buffer of the currently displayed frame. This bar is also used to display bookmarks. In the same display panel as the progress bar is a numerical description of the frame number, the total number of frames in memory and the time of the current frame relative to the start of the memory.

23. Clip Select menu

This menu relates to selecting the video clip to be saved on the Compact Flash card.

Access: Home ▸ Playback ▸ Player ▸ Clip select

Options: Clip start Clip end I◀ ▶I Settings Save

- The CDU will display the playback images selected by the clip select controls

❍ **Clip Start and Clip End Controls**

The player controls are used to locate the start and end of the desired video clip and the Clip Start and Clip End controls are used to mark the chosen frames.

❍ **Player Controls**

The I◀ and ▶I controls will cause the player to immediately move either to the next bookmark or to the beginning/end of the memory.

❍ Settings

Quality Control

This control permits the user to apply JPEG compression to the image before it is saved onto the Compact Flash card. In this way, it is possible to increase the number of video images stored on the card and increase the speed of writing images to the card. The compression used is compatible with the all versions of the Olympus *i*-SPEED, *i*-SPEED 2 and *i*-SPEED TR viewer and PC software. If the user wishes to encode the clip as a standard Windows avi, the *i*-SPEED TR PC software and viewer software provide this functionality.

NOTE

The maximum file size for an *i*-SPEED TR movie is 2GB.

❍ Save Control

If the start and end frames are selected as the same frame, the save control will cause the camera to save a single bitmap (BMP) or JPEG image to the card. If more than one frame is chosen, the camera will save a movie file to the card.

On Screen Information

The Clip Select menu provides a progress bar to indicate the position in the buffer memory of the currently displayed frame as well as the start and end frame markers. This bar is also used to display bookmarks.

In the same display panel as the progress bar is a graphical representation of the available memory in the card, the total memory in the card and the quantity of memory required for the currently selected clip.

In a separate display panel is a numerical description of start frame number relative to the start of the camera's memory, the number of frames selected, the size of the chosen clip and the available free memory in the card.

NOTE

The Olympus *i*-SPEED TR High speed video camera produces video files in a proprietary format. The files have the unique file name extension .hsv. For example a file may be named "Test.hsv". These files may be played in the *i*-SPEED TR PC software supplied with the camera and also in the free *i*-SPEED TR viewer software. Both of these pieces of software are also able to convert the file type to the Windows .avi format. The exact encoding provided by the *i*-SPEED TR PC Software and the *i*-SPEED TR Viewer Software depends on the CODECs installed in the user's PC.

24. Config menu

This menu makes available items relating to configuration of the camera. The 'More' options screen is shown in Section 29.

Access: Home ▸ Setup ▸ Config

Options: *Ethernet* *Date/Time* Monitor Standard *Camera ID* *Battery status* *More*

•The CDU will display the splash screen logo

❍ Monitor standard

The composite video output connector (BNC) is able to provide either NTSC or PAL and this selection is made by this control.

25. Ethernet menu

When using multiple cameras in conjunction with the PC software, each camera will need to have a unique TCP/IP address. Every *i*-SPEED camera has a default address of 192.168.0.54 and a default subnet mask of 255.255.255.0. These controls allows these settings to be configured for each camera on the network. Once set, the TCP/IP address and subnet mask will be stored in the camera's memory.

The choice of address and subnet mask is dependent on the individual network being used and should be chosen by the network administrator. When the appropriate address and subnet mask have been set, the OK button should be pressed.

Access: Home ▸ Setup ▸ Config ▸ Ethernet

Options: IP ADDRESS SUBNET MASK DHCP OK

- **IP ADDRESS**

  Allows the user to enter the chosen TCP/IP address.

- **SUBNET MASK**

  Allows the user to enter the chosen subnet mask.

- **DHCP Control**

  When a piece of equipment is connected to Ethernet, it is known to other equipment on the network by its TCP/IP address. This may be set manually (as above) or automatically using a system called DHCP.

If the network already has a DHCP server (most likely in pre-installed networks which include a server computer) then this may assign the camera a TCP/IP address. To enable this, set the DHCP to client.

If the network does not have a DHCP server, but contains other computer which are usually connected to a large network, and are therefore configured as clients, then the camera can act as the network's DHCP server and assign the other computers unique TCP/IP addresses. As a guideline, a network should either have A) 1 DHCP server and 1 or more clients or B) all equipment should have static IP addresses and DHCP is not used. This is an advanced topic and the user is advised to refer to his network administrator as appropriate.

❍ OK Control

This control confirms the numerical entry just made and also returns to the previous menu.

26. Time / Date Setting menu

This menu permits the setting of the time and date of the on-board clock of the camera.

When the appropriate time and date have been set, the OK button should be pressed.

Access: Home ▸ Setup ▸ Config ▸ Time/Date

Options: Year Month Day Hour Minute Format OK

- **Year, Month, Day, Hour, Minute Controls**

  Allows the user to set the date and time.

- **Format Controls**

  Allows the user to choose the display format for the date and time.

- **OK Control**

  This control confirms the numerical entry just made and also returns to the previous menu.

27. Camera ID menu

The Olympus *i*-SPEED TR camera is capable of connection to an Ethernet network. It is possible to connect more than one camera and, whilst the cameras are uniquely identified by their TCP/IP address, it is sometimes useful to have a simple user settable ID tag which is kept with the downloaded video. This control allows the setting of this tag.

Access: Home ▶ Setup ▶ Config ▶ Camera ID

Options: OK Cancel Select Delete ◀ ▶ ▲ ▼

- **Select Control**

  Enters the character highlighted in the name bar.

- **Delete Control**

  Deletes characters from the name bar.

- **OK Control**

  Saves the entry.

- **Cancel Control**

  Returns to the previous menu.

- **◀ ▶ ▲ ▼ Controls**

  Navigates the character set.

28. Battery status menu

This information page is provided for users who are interested in the status of the battery in their *i*-SPEED TR camera, it is not essential to the operation of the camera.

Access: Home ▸ Setup ▸ Config ▶ Battery status

29. More menu

This menu makes available items relating to configuration of the camera.

Access: Home ▸ Setup ▸ Config ▸ More

Options: System restore Language Camera update
TV Output Graphics *Advanced Setup*

- **System Restore**

  This function will permanently remove all of the settings entered by the user, including speeds, shutters, TCP/IP settings, user settings, name tags and so forth. The setup of the camera will be the same as when it was first shipped from Olympus. It may be considered as the next more severe reset after Home ▸ User Settings ▸ Default.

  This function is included for users who wish to protect their security or who have made too many setting changes and wish to completely start again.

- **Language**

  This control permits the user to set the language in which the menu's are displayed. The language of the information tiles and control value display is not changed.

- **Camera update**

  This allows the user to update the camera software or firmware using a Compact Flash card.

- **TV Output graphics**

  This control allow the user to choose whether the graphics shown on the CDU are to be overlaid on the video image of the Video out (composite) and S-Video outputs.

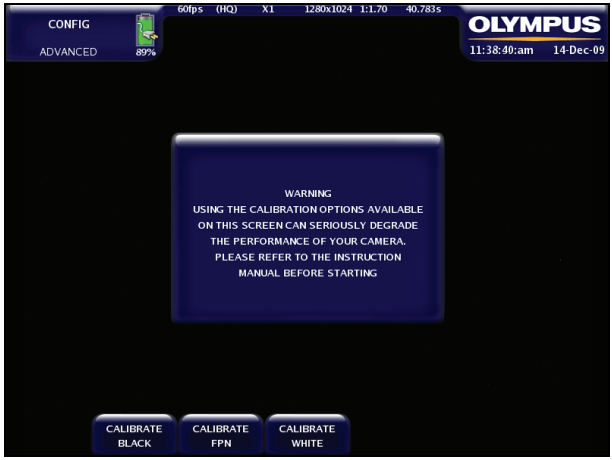
30. Advanced Setup menu

CAUTION

- Using the calibration options available on this screen can seriously degrade the performance of your camera. Please read and understand this section before starting. Only use these options when required.
- This menu provides options for the user to recalibrate some features of the camera. This is not typically required during normal use of the camera. These options may be required after some camera software and/or firmware updates. If these options are required their use will be detailed in the update documentation.
- Before using these options it is important that the camera is using the default settings. This is most easily accomplished by turning the camera off and back on before proceeding directly to this menu without making any other selections.
- These options should always be applied in the order in which they are presented ie. Calibrate Black then Calibrate FPN and lastly Calibrate White. There is no need to exit the menu in-between applying these options.

Access: Home ▸ Setup ▸ Config ▸ More ▸ Advanced Setup

Options: Calibrate Black Calibrate FPN Calibrate White



❍ Calibrate Black

This function allows the camera to learn the black level characteristics of its sensor. Before selecting this option ensure the following (there is no confirmation prompt on selection):

- The camera is using the default settings from power on - see Caution above.
- There is no lens fitted to the camera and the cameras body cap is fitted such that the image is completely black.

Once selected a 'Calibrating' message will show on the CDU and the i-CHEQ status lights will flash. Do not remove the body cap or interrupt the power until a 'Calibration complete' message is displayed and the i-CHEQ status lights are turned off. The process will take a few tens of seconds (less than a minute).

❍ Calibrate FPN

This function allows the camera to learn the Fixed Pattern Noise characteristics of its sensor. Before selecting this option ensure the following (there is no confirmation prompt on selection):

- The camera is using the default settings from power on - see Caution above.
- There is no lens fitted to the camera and the cameras body cap is fitted such that the image is completely black.
- The Calibrate Black function has been performed.

Once selected a 'Calibrating' message will show on the CDU and the i-CHEQ status lights will flash. Do not remove the body cap or interrupt the power until a 'Calibration complete' message is displayed and the i-CHEQ status lights are turned off. The process will take a several tens of seconds (more than a minute).

❍ Calibrate White

This function allows the camera to learn the white level characteristics of its sensor. Before selecting this option ensure the following (there is no confirmation prompt on selection):

- The camera is using the default settings from power on - see Caution above.
- There is no lens fitted to the camera. The cameras body cap is removed and there is sufficient light such that the image is completely white.
- Both the Calibrate Black and Calibrate FPN functions have been performed.

Once selected a 'Calibrating' message will show on the CDU and the i-CHEQ status lights will flash. Do not fit the body cap or interrupt the power until a 'Calibration complete' message is displayed and the i-CHEQ status lights are turned off. The process will take a few tens of seconds (less than a minute).

6.2 Measurement system

The Olympus *i*-SPEED TR camera has a built-in measurement system which is based on the principle of comparative measurement whereby measurement is achieved by entering the size of a known object in the image and then comparing this with the size to be measured.

The measurement suite is intended to give a good indication of relative object distance, speed and angle. However, due to the number of variable factors involved, no guarantee of measurement accuracy can be given.

The Measurement system is able to measure distance and speed, as well as angle and angular velocity.

Distance

The cursor is placed on the start point of the measurement and the Start Point button is pressed. As the cursor is moved, a line will be drawn from the cursor back to the start point and the distance will be given.

Speed

If the user also enters the player and moves back or forward by a few frames, then the cursor will now not only have moved some distance from the start point, but some time from it as well. Since speed is defined as distance moved over time, the measurement system will now provide a speed reading as well.

Angle, Angular Velocity

These functions operate in exactly the same manner as the distance measurements, except that the user must first define an Origin Point which will be used as the centre of the rotation.

IMPORTANT: The entire reference measurement and the entire measurement of interest must be coplanar, in a plane orthogonal to the axis of the camera. This means that for distance and speed measurements, the scene must contain an object whose size is accurately known. Also, this object must be the same distance from the lens as the object being measured.

Furthermore, the start and end points of the known measurement and the start and end points of the measurement of interest must all be the same distance from the camera. For angle and angular velocity measurements, the origin, start and end points of the measurement must all be the same distance from the camera.

The accuracy of measurement depends on the conditions above being fulfilled and on the skill of the operator in placing the on screen cursors accurately.

This system does not take account of any geometric distortion added by the user's lens.

1. Measure menu

This is the home or start-up screen of the measurement system. Before the system is used, set the Linear/angular units of measurement and calibrate the system by measuring an object of known dimensions using Linear CAL.

Access: Home ▸ Playback ▸ Measure

Options: *Linear CAL* *Linear units* *Linear measure* *Angular units* *Angular measure* *Colour*

•The CDU will display the playback image

❍ Linear units

Linear units of measurement are shown below.

Distance	m	yards	feet	inches	cm	mm	
Speed	mph	km/h	km/s	m/s	ft/s	in/s	cm/s

❍ Angular units

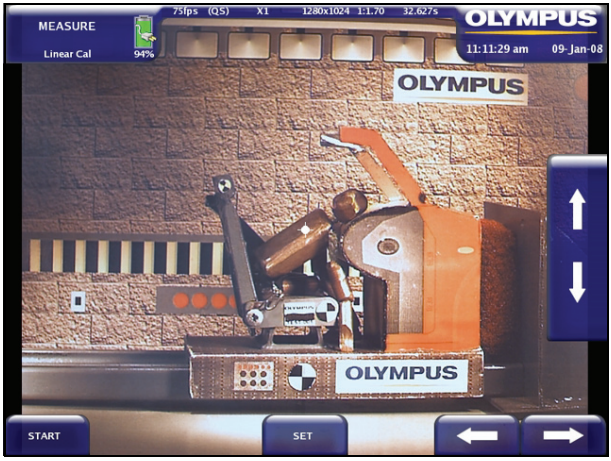
Angular units of measurement are shown below

Angle	grad	rad	deg		
Angular velocity	rpm	rps	grad/s	rad/s	deg/s

2. Linear Calibration menu

Access: Playback ▸ Measure ▸ Linear CAL

Options: Start Set ◀ ▶ ▲ ▼



- **◀ ▶ ▲ ▼ Controls**

  These controls allow the user to move the measurement cursor.

- **Start Control**

  Position the cursor as described above and press Start to mark the start of the measurement for calibration.

Set Control

Position the cursor as described above and press Set to mark the end of the known distance which is used for calibration. The following screen will be displayed where the known measurement should be entered using the appropriate controls. Confirm the unit of measurement is correct and press OK. The system returns to the measurement screen.

3. Colour menu

Access: Playback ▸ Measure ▸ Colour

Options: Line colour Line shadow Text colour Text shadow

- **Line colour / Text colour**

  The line and text colour controls allow the user to select the colours of the on-screen cursor and text to improve legibility against different backgrounds.

- **Line shadow / Text shadow**

  These controls are used to set line/text shadow ON or OFF.

4. Linear measurement menu

Access: Playback ▸ Measure ▸ Linear measure

Options: Start point Player Save ◀ ▶ ▲ ▼

•The CDU will display the playback image

❍ **Start point Control**

This control marks the start of the measurement.

❍ **Player Control**

The player is presented here to allow the measurement of speed by permitting the user to move to a different frame for the middle and end points of the measurement.

Save Image

This control causes an image to be saved to the Compact Flash card. The user is offered the opportunity of creating a meaningful name for the saved image. The image will be saved exactly as it is seen on the CDU, with a resolution of 800 x 600 pixels, regardless of sensor resolution. Any image processing selected in the Picture menu will also be included. The saved image will be in bitmap format only.

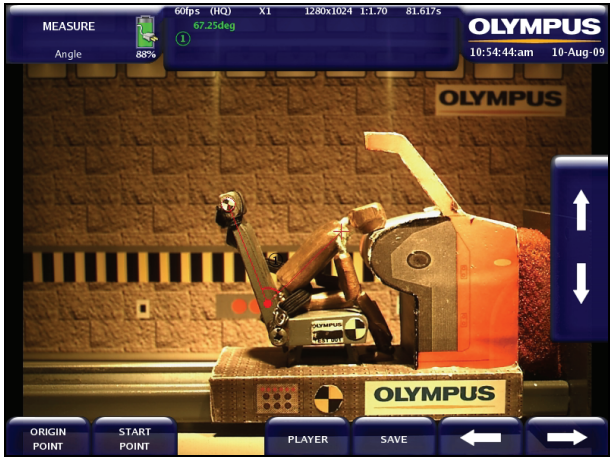
◀ ▶ ▲ ▼ Controls

These controls allow the user to move the measurement cursor.

5. Angular measurement menu

Access: Playback ▸ Measure ▸ Angular measure

Options: Origin point Start point Player Save ◀ ▶ ▲ ▼



- **Origin Control**

  This control marks the origin or axis of rotation for the measurement of angle and angular velocity.

- **Start Control**

  This control marks the start of the measurement.

- **Player Control**

  The player is presented here to allow the measurement of angular velocity by permitting the user to move to a different frame for the middle and end points of the measurement.

- **Save Image**

  This control causes an image to be saved to the Compact Flash card. The user is offered the opportunity of creating a meaningful name for the saved image. The image will be saved exactly as it is seen on the CDU, with a resolution of 800 x 600 pixels, regardless of sensor resolution. Any image processing selected in the Picture menu will also be included. The saved image will be in bitmap format only.

- ◀ ▶ ▲ ▼

  These controls allow the user to move the measurement cursor.

Chapter 7 Embedded Software Reference (CDU) *i*-SPEED 3, *i*-SPEED FS & *i*-SPEED DF

Introduction

This reference section describes the *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF embedded software and its user interface from the viewpoint of the CDU. In this section, items which are printed *like this* signify the name of a sub menu, controls are described whenever they appear in a menu.

Operation of the CDU menus

To navigate through the menu system, the button nearest the desired selection is pressed.

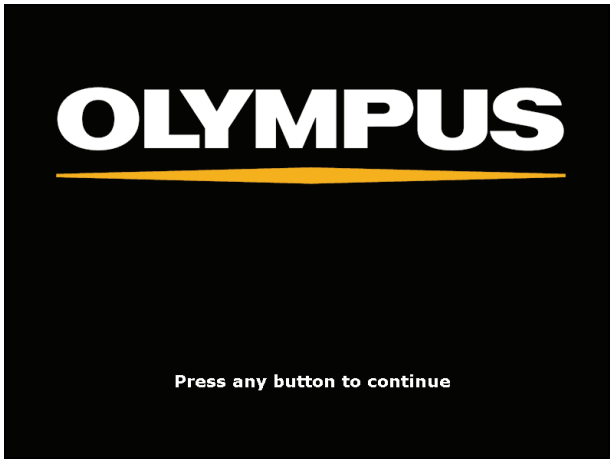
When a control is selected, the desired value may be chosen by using the ▲ and ▼ buttons on the right hand side of the screen. Repeatedly pressing or to press and hold the control button will cycle through the available values. The current value is displayed above the control button and also next to the ▲▼ buttons.

To return to a higher menu, the Back button is pressed. If there is a requirement for a text free screen, the Text button is used to cycle the on-screen text through full, time/date only and off options.

7.1 Menu screens

1. Splash Screen

   This screen is displayed while the camera starts up and configures the internal software, the software version number is displayed in the bottom right hand corner. To exit this screen, the user must press any button on the CDU.



2. Home menu

This is the top level or home screen of the menu system. It may be accessed by pressing the Back button repeatedly from any position in the menu system.

Options: Start Setup User Settings Playback Card Power Off

When the user enters the Home, Start or Picture menu, a luminance histogram window is displayed at the top of the CDU (see image above), which provides a real-time analysis of the image displayed on the CDU. The graph indicates the quantity of pixels in the image at each of the available brightnesses, with black on the left side and white on the right side. The graph may be understood as a pixel counter, the higher the graph at one point, the more pixels have been counted at that brightness. For example, if there are a lot of dark pixels, the graph will be high on the left and low on the right.

Interpretation of the graph is an acquired skill, but it is an extremely powerful tool. In general, if the graph is highest in the left area and flat at zero in the right, the picture is too dim. If the graph is highest in the right area and low in the left, the picture is too bright. A well balanced picture will have most parts of the graph somewhere in the middle.

Please note that if all the pixels were at the same brightness, the entire graph would be zero, apart from one very tall thin spike at that brightness. Naturally, the window is not tall enough to accommodate the height of this spike, so the graph is clipped to the size of the window.

❍ Power off

This control is used to Power down the camera. This function is the preferred method of turning the camera off. Protection against accident is provided by a confirmation box. This function is necessary, because attempting to turn the camera off by removing DC power will fail, since the camera will automatically switch to battery. The power button on the rear panel is also able to turn off the camera, but includes a 4 second timeout to prevent accidental switch-off.

3. Start menu

This menu provides rapid access to the most commonly used functions.

Access: Home ▸ Start

Options: Rec Speed Shutter Optimize Zoom Picture *i*-Focus

Speed Control

This control allows the user to set the frame speed of the camera. The lowest speed available is 1 frame per second and the maximum speed is 150,000fps for *i*-SPEED 3, 1,000,000fps for *i*-SPEED FS and 300,000 for *i*-SPEED DF.

The desired speed can be set by either selecting a value from the preset speeds list or manual entry down to 1fps resolution. The control mode of the speed selection may be switched in Home ▸ Setup ▸ Control Mode ▸ Frame Speed.

As described in "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF", the user will normally need to open the iris of the lens and/or add more light as the speed is increased. Further, the image will appear to zoom in as the frame speed is increased above 2,000 frames per second.

Shutter Control

It is sometimes desirable to reduce the time during which the sensor gathers light (called "exposure time", "integration time" or "shutter time") in order to reduce motion blur and "freeze" the motion in each frame. The default shutter time is equal to the frame time, but this may be reduced by this control. The shutter time is

measured as the ratio between frame time and shutter time, e.g. x10 means that the shutter is open for 1/10 of the frame period. The shutter period may range from the frame period (x1) to a ratio that corresponds to a minimum of 2.16μs or 1μs (or 0.2μs for *i*-SPEED FS) depending on the optimize mode chosen.

Note that the image sensor requires time to reset ready to capture each frame, so x1 is an approximation and that at the highest speeds this may not be available.

Some users prefer to operate the shutter in terms of time, so that the shutter period does not change when the frame speed is changed. The *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF shutter control may be switched to this mode in Home ▸ Setup ▸ Control Mode ▸ Shutter Mode.

The desired shutter time can be set by either selecting a value from the preset shutter time list or manual entry down to 0.01μs resolution. The control mode of the speed selection may be switched in Home ▸ Setup ▸ Control Mode ▸ Shutter Time.

Note that if a long shutter time is chosen and the frame speed is then increased, the long shutter time will not be possible. Under these circumstances the *i*-SPEED 3*, i*-SPEED FS, *i*-SPEED DF will clip the shutter time, but if a lower frame speed is selected, the *i*-SPEED 3*, i*-SPEED FS, *i*-SPEED DF will not move the shutter time back again.

The user should note that as the shutter ratio is increased or shutter time is decreased, the camera will require more light.

- **Optimize**

  This option optimises the camera's image sensor in one of several configurations. HQ provides the highest quality images, QS provides good quality images but with improved top speed and shutter. *i*-SPEED FS cameras have a third configuration, FS, which provides the fastest speed and shutter. *i*-SPEED DF cameras have a different third configuration, SIF, which provides the shortest delay between successive frames.

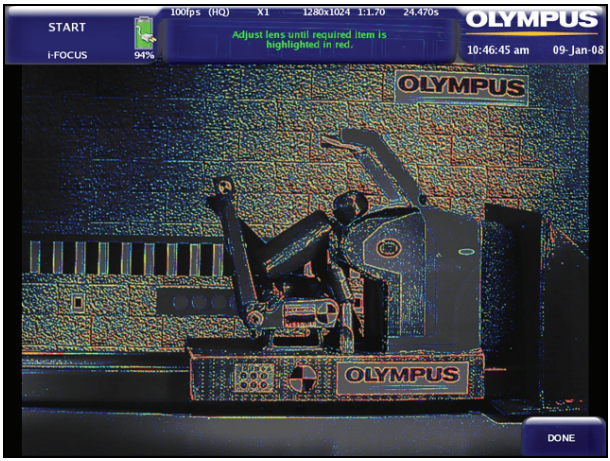
4. *i*-FOCUS

This function enables the user to focus the camera more accurately, especially when using a display with less resolution than the camera. i-FOCUS presents a basic image without colour and with reduced brightness, but with focussed areas highlighted in red. Less well focussed areas are coloured yellow, then green, then blue. Unfocussed areas are not coloured.

With this feature, the user can easily locate the area of interest in the image and then adjust the focus ring of the lens to achieve the maximum possible focus in these areas, or achieve a compromise of focus in multiple areas of interest.

Access: Home ▶ Start ▶ *i*-Focus

Options: Done



❍ **Done**

Returns the user to the previous screen.

5. Setup menu

Access: Home ▶ Setup

Options: *Trigger & Sync* *Sensor* *Economy* *Permanent Text* *Control Mode* *Config*

6. User settings menu

The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has the ability to save and recall most of the settings applied by the user. These may be saved / recalled from a Compact Flash card (if one is installed) or from the camera's internal memory. The user may store the settings on a CF card, remove the card and install it in a different *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera running the same release of software. In this way the user may carry a set of favourite settings with him from camera to camera, or leave his preferred settings in a camera.

Access: Home ▸ User Settings

Options: Load default Load last Load New cam New card Save Delete

- **Load default**

  This function sets the camera to a sensible configuration. It is intended as a rescue function when a user has changed more settings than he can remember.

- **Load last**

  At power-off, the camera stores the settings in internal memory and these may be recalled after a new switch-on.

- **Load**

  The user may load settings from either the Compact Flash card (if one is installed) or the camera's internal memory. The source of the load is indicated by the highlight in the list of names at the side of the CDU.

- **New CAM**

  This option allows the user to create a new name in one of the camera's save spaces.

- **New CARD**

  This option allows the user to create a new name and file in the Compact Flash card (if one is installed).

- **Save**

  The user may save the current settings. They may be either saved to the Compact Flash card (if one is installed) or in the camera's internal memory. The destination of the save is indicated by the highlight in the list of names at the side of the CDU. The camera has a fixed number of save spaces, but the card is limited only by available storage.

- **Delete**

  The user may delete settings from either the Compact Flash card (if one is installed) or the camera's internal memory. The settings to be deleted are indicated by the highlight in the list of names at the side of the CDU. If card settings are deleted, the file is physically removed from the CF card.

  A status bar at the top of the screen shows the number of slots free in internal memory and on the Compact Flash card.

  A small graphic will appear to the top right hand side of the screen when the *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is accessing the Compact Flash card. The graphic will disappear when it is safe to remove the card.

7. Playback menu

This menu makes available all the items which relate to the playback view systems of the camera. The playback menu is not available until a recording has been made.

Access: Home ▸ Playback

Options: *Player Picture Zoom Measure*

- Automatically appears after recording has stopped and displays the playback image.

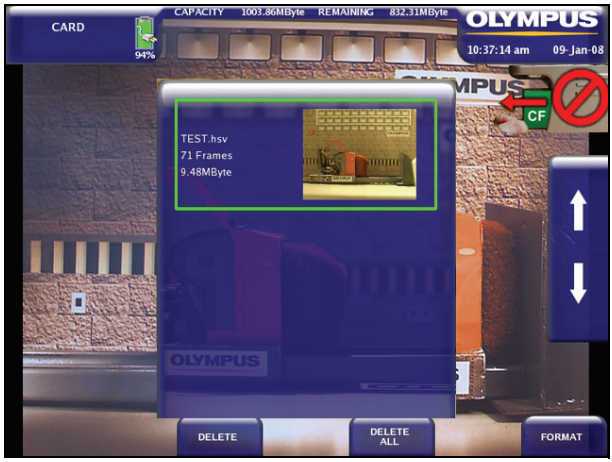
8. Card menu

This menu makes available the items which relate to the management of the removable Compact Flash card.

The screen displays a thumbnail of each video file on the card and one of these will be highlighted by a colour border.

Access: Home ▸ Card

Options: Delete Delete All Format



- **Delete**

  This control is used to delete the selected file from the card. The user is protected from error by a confirmation question.

- **Delete All**

  This control is used to delete all files from the card. The user is protected from error by a confirmation question.

- **Format**

  The user is able to format the card. This will delete all the data on the card and also prepare a new card for its first use in the camera. The user is protected from error by a confirmation question.

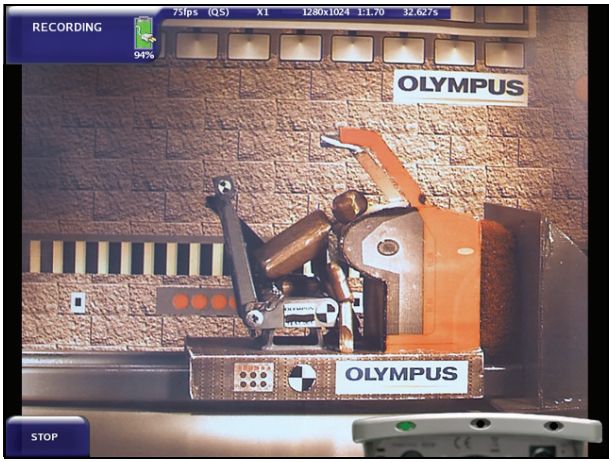
9. Recording menu

When the recording screen is displayed, the Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is recording video into its circular buffer. The record action is confirmed by the presence of an animated camera on-screen and the LED indicators on the handle - see description and table below.

When recording has stopped, whether by the trigger or the STOP button on the CDU, the camera will automatically present the Playback menu and thereby display the first recorded image in the memory.

Access: Home ▶ Start ▶ Record

Options: Stop



Located in the Protective Bar / Handle of the Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF are three multi-coloured LED indicators. These give the user an indication of the status of the camera. These are useful when the camera is located some distance from the user, but is still visible, or when the camera is not connected to a control device, such as the CDU or a PC.

The *i*-CHEQ status indication is provided by differing colour and motion as listed in the table below.

Camera operation	Mode	Status	Pattern
Start-up		Camera software booting	Blue, sweeping left to right
Record	Normal	No trigger received	Green, sweeping left to right
Record	Normal	Trigger received, timeout in progress	Green, alternating left & right
Record	ROC BROC	Waiting for trigger to start burst	Green, sweeping left to right
Record	ROC BROC	Burst recording in progress	Green, alternating left & right
Record	Stopped	Done (end of memory or trigger timeout complete)	All LEDS fixed Green
Error	Error	An internal error has been detected	All LEDs rapidly flashing red simultaneously.
All	Power button	Power button pressed	All LEDs rapidly alternating red / blue simultaneously. After 1 second, right LED extinguishes, after another 1 second centre extinguishes, after another 1 second left fades for 1 second. 4 seconds in total.

❍ STOP Control

This control will cause the camera to stop recording immediately, regardless of the setting of the trigger position.

10. Picture menu

This menu enables the user to apply image processing to the live picture on the CDU screen to improve the visibility of details in the image. Any processing applied via this menu may optionally be applied to the images saved onto the Compact Flash card. If the Ethernet connection is invoked subsequent to the application of image processing, the images transferred to the PC will also include this processing.

NOTE

Some of the picture menu options are not available for a mono camera.

Access: Home ▶ Start ▶ Picture
Home ▶ Playback ▶ Picture

Options: *Brightness* *Contrast* *Invert* *Colour* *Enhance* *White Balance* Reset All

❍ Reset All Control

All of the image processing functions, including Brightness, Contrast, Invert, Colour and Enhance may be applied to the picture simultaneously. It is therefore possible to lose track of which controls have caused what effects, so a reset control is available to set Brightness, Contrast, Invert, Colour and Invert to their default values.

11. Brightness menu

The controls in this menu permit the user to alter the “brightness” of the image. This control mimics the operation of the “brightness” control in CRT video monitors by altering the black level of the image. Although this alters the appearance of the image, it is often helpful in making detail hidden in dark areas become more visible. Since a video image is made of the primary optical colours, red, green and blue, these colours may be individually adjusted, or all may be adjusted together.

Access: Home ▶ Start ▶ Picture ▶ Brightness
Home ▶ Playback ▶ Picture ▶ Brightness

Options: All Red Green Blue Reset

- **All Control**

  Permits all colours to be adjusted together.

- **Red/Green/Blue Controls**

  Permits individual colour adjustment.

  NOTE These controls are not available for a mono camera.

- **Reset Control**

  Resets all adjustments to original values.

12. Contrast menu

The controls in this menu permit the user to alter the “contrast” of the image. This control mimics the operation of the “contrast” control in CRT video monitors by linearly adding gain to the image. This is often helpful in making obscure detail become more visible and compensating for poor or harsh lighting conditions. Since a video image is made of the primary optical colours, red, green and blue, these colours may be individually adjusted, or all may be adjusted together. Individual adjustment is also useful for altering the colour balance of an image, to compensate for (or imitate) coloured ambient illumination.

Access: Home ▶ Start ▶ Picture ▶ Contrast
Home ▶ Playback ▶ Picture ▶ Contrast

Options: All Red Green Blue Reset

- **All Control**

  Permits all colours to be adjusted together.

- **Red/Green/Blue Controls**

  Permits individual colour adjustment.

  NOTE

  These controls are not available for a mono camera.

- **Reset Control**

  Resets all adjustments to original values.

13. Invert menu

This control permits the user to invert the colours of the image, like a photographic film negative. Although this dramatically alters the appearance of the image, it is sometimes helpful in making an obscure detail become more visible. Since a video image is made of the primary optical colours, red, green and blue, these colours may be individually inverted, or all may be inverted together.

Access: Home ▶ Start ▶ Picture ▶ Invert
Home ▶ Playback ▶ Picture ▶ Invert

Options: All Red Green Blue Reset

- **All Control**

  Permits all colours to be inverted together.

- **Red/Green/Blue Controls**

  Inverts individual colours.

  NOTE

  These controls are not available for a mono camera.

- **Reset Control**

  Resets all adjustments to original values.

14. Colour menu

This control permits the user to alter the colour saturation (depth of colour) of the image. If this control is set to the lowest value, the image will become monochrome. This can be useful in making some features of the image more visible.

NOTE

This function is not available for a mono camera.

Access: Home ▶ Start ▶ Picture ▶ Colour
Home ▶ Playback ▶ Picture ▶ Colour

Options: All Cr Cb Reset

- **All Control**

  This allows the user to change the colour saturations of the two colour components, Red difference (Cr) and Blue difference (Cb) together.

- **Cr / Cb Controls**

  This allows the user to change the colour saturations of the two colour components, Red difference (Cr) and Blue difference (Cb). This is sometimes useful in highlighting a feature in the image, such as one object passing in front of another which is similarly coloured.

- **Reset Control**

  Resets all adjustments to original values.

15. White balance menu

This menu enables the user to set the correct white balance depending on the lighting used.

NOTE

This function is not available for a mono camera.

Access: Home ▶ Start ▶ Picture ▶ White balance
Home ▶ Playback ▶ Picture ▶ White balance

Options: Mode White balance set

❍ Mode Control

Several preset white balance settings are provided, based on light source technologies found in the Olympus range of industrial light sources.

❍ White balance set Control

Performs an automatic white balance process. Before pressing this control, the user must place a pure white reference (sheet of paper etc.) in front of the camera, completely filling the field of view. This must not be removed until the white balance is complete. An on screen message shows the status of the white balance process.

Please refer to "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF" for a further description.

The control is only available if the white balance mode is set to automatic.

NOTE

Once this is set, the white balance setting is stored in the camera's internal memory.

16. Enhance menu

This menu enables the user to apply digital enhancements to the live picture on the CDU screen to improve the visibility of details in the image.

Access: Home ▶ Start ▶ Picture ▶ Enhance
Home ▶ Playback ▶ Picture ▶ Enhance

Options: Sharp Level Sharp Mode Gamma GTP Gain Reset

- **Sharp Level Control**

  The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is able to digitally enhance the on-screen image. This enhancement is based on two-pole, two-dimensional edge detection and is carefully phase matched to the video signal. This control adjusts the quantity of enhancement added.

- **Sharp Mode Control**

  This control allows the user to take advantage of the advanced image enhance processing in the *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF by displaying normal images, only edge detail or colour mapped edge detail.

❍ Gamma and GTP Controls

Gamma may be applied to the image to make darker areas more visible without destroying brighter areas of the image. Gamma, however, naturally reduces the colouration of the image and the GTP function is provided to reduce the effect of this reduction.

NOTE

The GTP function is not available for a mono camera.

Gamma is the complement to Dynamic Range Extension which reduces the sensitivity of the sensor in extremely bright areas without reducing sensitivity in dark areas.

❍ Gain Control

This allows the user to add gain to the image, to make dim images brighter. The addition of gain inevitably will increase image noise a little, but the *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF sensor has low noise characteristics, so this should not prove to be intrusive.

❍ Reset Control

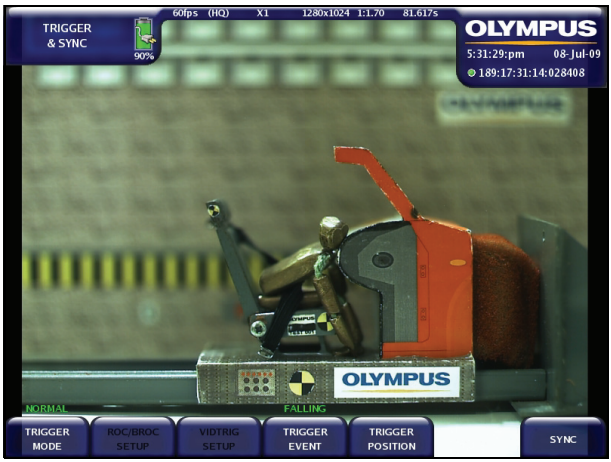
Returns all values in this menu to their default settings.

17. Trigger and Sync menu

This menu relates to trigger modes and settings. It would be of benefit to read "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF" for further descriptions on several of the terms and phrases used in this section.

Access: Home ▶ Setup ▶ Trigger & Sync

Options: Trigger Mode *ROC/BROC setup* *VIDTRIG setup*
Trigger event *Trigger position* *Sync*



- **Trigger Mode Control**

  This control is used to change the camera into one of the following modes of operation:

  Normal, ROC (Record On Command), BROC (Burst Record On Command), Video, Video ROC, Video BROC.

- **Trigger Edge Control**

  This control sets the trigger detection system to wait for a rising edge or a falling edge on the trigger input connection.

18. ROC/BROC setup

This menu relates to trigger modes and settings. It would be of benefit to read "Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF" for further descriptions on several of the terms and phrases used in this section.

Access: Home ▶ Setup ▶ Trigger & Sync ▶ ROC/BROC setup

Options: Clear last Clear mem Burst frames

❍ Clear Last Control

Pressing this control deletes the last burst recorded in ROC or BROC mode. This control is not available in normal trigger mode, or if no burst is available for deletion.

❍ Clear Mem Control

Pressing this control deletes the entire contents of the memory, permitting further use of the ROC or BROC modes. This control is not available in normal trigger mode, or if no burst is available for deletion.

❍ Burst Frames Control

This sets the length of the bursts recorded when the trigger is activated in BROC mode.This control is not available in normal trigger or ROC modes.

19. Video Trigger setup

The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has a 3 area video trigger which takes an average of the image brightness in each of the 3 areas and triggers the camera when any of the averages changes suddenly. The system shows the average brightness by drawing a white line in an on-screen graph and shows the sensitivity setting by adding a box to the graph. The box indicates lower sensitivity with a greater width, since the system will only trigger when the end of the graph exits the box. When this occurs, the box will turn red. The sensitivities and regions of interest may be independently configured and the regions can be independently activated and deactivated.

Access: Home ▶ Setup ▶ Trigger & Sync ▶ Vidtrig setup

Options:

Area 1 setup	Area 1 ON/OFF
Area 2 setup	Area 2 ON/OFF
Area 3 setup	Area 3 ON/OFF

❍ Area 1, 2, 3 ON/OFF Control

Activates/deactivates Areas 1, 2 and 3 as required. When activated, a box representing the region of interest is displayed and the Area setup control is activated.

❍ Area 1, 2, 3 Setup Control

Activates the region of interest box and provides Top Left, Bottom Right and Sensitivity tools to size and position the box as required.

20. Trigger Position menu

This control sets the length of the trigger delay, so that the trigger point will appear at a user-settable position in the recorded video clip. With the trigger position at 0%, the trigger delay is equal to the length of the circular buffer and the trigger point will appear at the beginning of the video clip. With the trigger position at 100%, the trigger counter is set to zero and the recording will stop immediately the trigger is activated, thus the trigger point will appear at the end of the video clip.

NOTE

This control is not available in ROC and BROC modes.

Access: Home ▶ Setup ▶ Trigger & Sync ▶ Trigger position

Options: Start Mid End ◀10% ▶10% ◀ Frames ▶ Frames

❍ Start, Mid, End Controls

These controls allow the user to set the trigger position to the start, middle, or end point of the recording. If End is selected, the recording will stop immediately a trigger is received, so that the trigger point is the last frame of the resultant clip

- **10% Controls**

  These controls allow the user to set the trigger position in steps of one tenth of the length of the cameras memory.

- **Frames Controls**

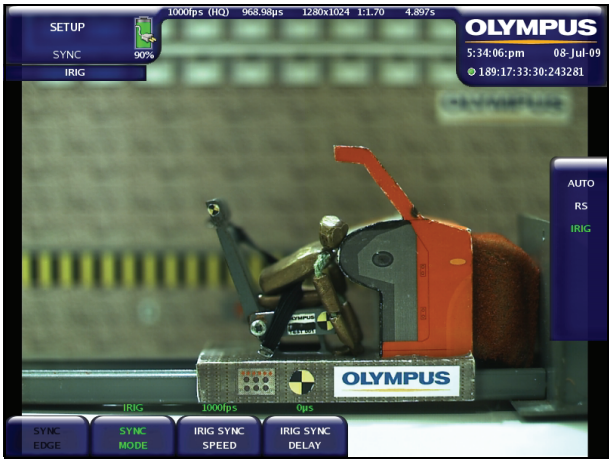
  These controls allow the user to set the trigger position to the desired frame number with complete accuracy. When setting to an absolute frame number, the user is advised to use the 10% controls first in order to save time.

21. Sync

The sync menu enables the user to configure the synchronisation options for ensuring that frames are synchronised to external signals.

Access: Home ▶ Setup ▶ Trigger & Sync ▶ Sync

Options: Sync edge Sync mode



❍ Sync Edge Control

This control sets the sync detection system to wait for a rising edge or a falling edge on the sync input connection.

❍ Sync mode Control

This control sets the operation mode of the sync detection system. The following choices are available:

Auto - This mode allows the frame speed of the camera to be locked to an external signal and ensures that the start of exposure of each frame is synchronised to the selected edge transition of that signal.

RS (Random Snapshot) - This mode allows the camera to take a single frame for every selected edge transition of an external signal and ensures that the start of exposure of each frame is synchronised to that edge transition.

IRIG (*i*-SPEED FS only) - This mode allows the camera to be locked to an external IRIG timing signal and ensure that the start of exposure of each frame is synchronised to the selected edge transition of that signal. Refer to "Chapter 8 Special features of the i-SPEED FS".

DF (Double Frame, *i*-SPEED DF only) - This mode allows the camera to take two frames for every selected edge transition of an external signal. Use of the Double Frame sync mode is available only via PC control. A Software Development Kit (SDK) is available for customers who wish to use this functionality. Please contact Olympus for further information.

22. Sensor

The sensor menu enables the user to enhance the image in poor light conditions.

Access: Home ▶ Setup ▶ Sensor

Options: Dynamic range Enhanced sensitivity

❍ Dynamic range

This option is used to extend the dynamic range of the sensor by “Dual Slope Integration” Some manufacturers refer to this as “SR Technology”. The effect is to maintain the sensitivity of the sensor in dark areas and reduce it in light areas. This function may therefore be useful in scenes which contain bright highlights as it will make the lighter areas more visible. Note that this function degrades colour rendition in colour cameras.

This function is the complement to the Gamma and GTP post-processing function, which leaves bright areas unaltered but brightens dark areas.

Further discussion may be found in “Chapter 9 Understanding the Olympus i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF”

❍ Enhanced Sensitivity

This option may be used to add 2x gain into the analogue electronics in the Image Acquisition system at the front of the camera.

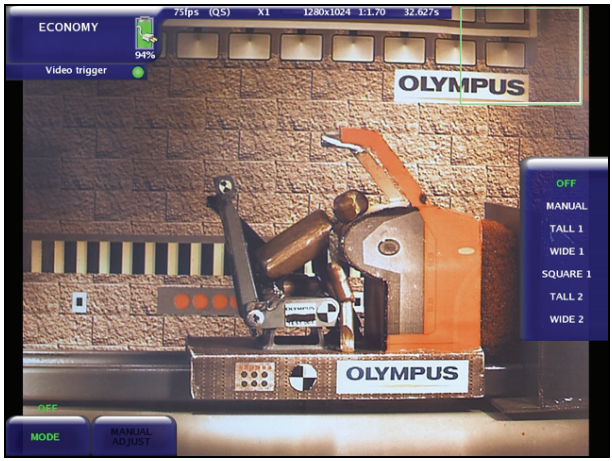
23. Economy

Many high speed events are primarily horizontal or vertical in nature and so the edges of the screen often contain no useful video information. It is also sometimes desired to have a longer record time than that given by the available memory option. This control addresses both of these issues by causing the camera to use a central subsection of the sensor, rather than the maximum available area. This has the effect of reducing the number of pixels recorded in each frame and so effectively increasing the record time available.

Where possible, the zoom engine will return the image to full screen.

Access: Home ▶ Setup ▶ Economy

Options: Mode Manual adjust



- **Mode**

  Enables the user to select from a range of preset economy modes.

- **Manual adjust**

  Allows the user to manually select an area using ◀ ▶ ▲ ▼ controls.

24. Permanent text

The camera can permanently and destructively overlay three lines of text plus a small logo onto the video images (Normal and Video trigger modes only), aligned to any of the 4 corners. The user may enter the first line of text. The second line of text will display a date/time stamp. This will be captured from the cameras internal clock at the start of exposure of each frame. In the case of an *i*-SPEED FS camera recording with IRIG timing, the date/time stamp will be captured from the IRIG timing data at the start of exposure of each frame. Refer to "Chapter 8 Special features of the i-SPEED FS". The third line displays the frame number prefixed by an F.

NOTE

Permanent text will not provide a date/time stamp when operating in Random Snapshot sync mode except for an *i*-SPEED FS camera recording with IRIG timing.

The user may also add a small logo to the area.

The logo must be supplied to the camera on a Compact Flash card and should be a .bmp file with 32(h) to 150(h) pixels in 16.7 million colours (24 bit) and should be in a folder called logos\permtext\ on the card.

Access: Home ▸ Setup ▸ Permanent text

Options: Mode Position Set text Text Colour Load logo

•The CDU will display the live image

❍ **Mode**

Sets the mode of operation, Off, Text, Text/Logo, Logo.

- **Position**

  Selects placement of the permanent text, top or bottom of the image and aligned to the left or right.

- **Set text**

  The user may enter one line of text.

- **Text Colour**

  The user may choose text colour and shadow properties.

- **Load logo**

  The logo must be supplied to the camera on a Compact Flash card and should be a .bmp file with 32(h) to 150(h) pixels in 16.7 million colours (24 bit) and should be in a folder called logos\permtext\ on the card.

  When Load logo is selected, each image on the CF card is displayed as a thumbnail and the user then selects the required image.

25. Control Mode menu

Access: Home ▸ Setup ▸ Control Mode

Options: Shutter Mode Shutter Time Frame Speed IRIG Sync Speed

- **Shutter mode**

  The shutter setting may be controlled in microseconds, selected by this setting. This will also apply if non-standard speeds are enforced by the external sync signal.

- **Shutter Time**

  The shutter time (when in microsecond shutter mode) may be selected by either selecting a value from the preset shutter time list or manual entry down to 0.01µs resolution. The mode of selection is chosen by this setting, the entry of the shutter time is by Home ▸ Start ▸ Shutter.

- **Frame Speed**

  The frame speed may be selected by either selecting a value from the preset frame speed list or manual entry down to 1fps resolution. The mode of selection is chosen by this setting, the entry of the frame speed is by Home ▸ Start ▸ Speed.

- **IRIG Sync Speed**

  NOTE

  This function is only available on *i*-SPEED FS cameras.

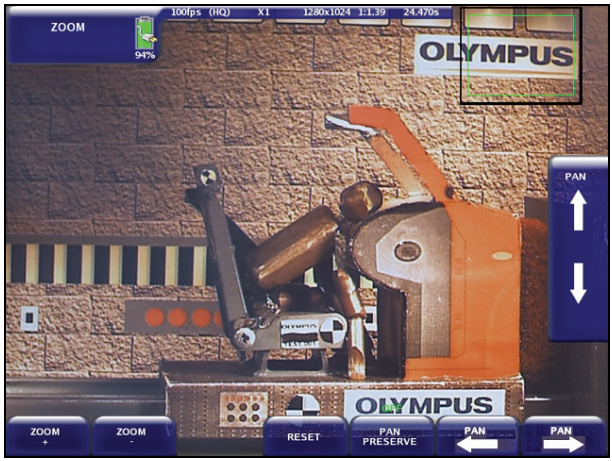
  The IRIG sync speed may be selected by either selecting a value from the preset IRIG sync speed list or manual entry down to 1fps resolution. The mode of selection is chosen by this setting, the entry of the IRIG sync speed is by Home ▸ Setup ▸ Trigger & Sync ▸ Sync ▸ IRIG sync speed.

26. Zoom / Pan menu

This menu provides access to the controls of the built-in zoom engine.

Access: Home ▸ Start ▸ Zoom
Home ▸ Playback ▸ Zoom

Options: Zoom+ Zoom- Reset Pan preserve Pan Left Pan Right Pan Up Pan Down



❍ Zoom Control

The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera has a built-in zoom engine which can electronically minify or magnify the video image. The user may adjust the level of zoom using the zoom control in this menu.

It should be noted that the zoom engine is automatically operated to fit the image from the sensor in the CDU screen. Minification is used when the sensor resolution exceeds the CDU resolution. For example, the CDU has a resolution of 800 x 600, but the sensor has a resolution of 1280 x 1024 at speeds up to 2,000fps. In this case, the minification engine will zoom out by 1:1.7 (also written as 0.586:1). When high frame rates result in the active area of the sensor being reduced below the CDU resolution or when the “square” economy mode is selected, the zoom engine will magnify the image to fit the CDU. In these circumstances, the user may still zoom further into the zoomed image, but there is a limit to the total zoom that may be employed.

- **Reset Control**

  Resets any pan and zoom adjustments to their default values.

- **Pan Control**

  For the convenience of the user, pan controls are also provided. These are individually disabled when the limit of the pan in a given direction is reached, and all are disabled when the zoom engine is turned off (1:1).

- **Pan Preserve Control**

  When the user zooms into an image, the region of interest may move outside the field of view. In this case, the user will use pan to move the region of interest back into the field of view. If the user then zooms out again, the pan settings would cause the edge of the field of view to overhang the edge of the sensor, so the pan settings are adjusted to keep the field of view inside the active area of the sensor. When the user zooms in again, pan preserve will cause the original pan settings to be reinstated, whereas setting pan preserve to off will leave the pan settings to the more central, adjusted values.

27. Player menu

The player screen allows the user to play back and interact with the video stored in the circular buffer memory.

Access: Home ▸ Playback ▸ Player

NOTE

Also accessed from the measurement system

Options: Bookmark I◀ ◀ Clip select ▶ ▶I Loop

❍ Bookmark Control

This control is used to set bookmarks at points of interest. Pressing the button when already on a marked frame will remove the bookmark. Bookmarks are displayed in the progress bar at the top of the screen. For the convenience of the user, the trigger frame is automatically given its own bookmark, and this is coloured differently for clarity.

❍ Player Controls

The controls should be familiar to most users: jump back, play backwards, play forwards, jump forward. Clip select toggles to ■ (Stop) when the ◀ or ▶ buttons are pressed. Pressing and holding the play forwards or play backwards buttons will provide fast forward and fast rewind functions

The jump controls will cause the player to immediately move either to the next bookmark or to the beginning/end of the memory.

The speed of playback is controlled by the ▲ ▼ buttons on the right hand side of the CDU. The chosen playback speed is indicated in a label next to these buttons.

❍ Clip select

The Player controls are used to locate the start and end of the desired video clip and the Clip Start and Clip End controls on the Clip select menu are used to mark the chosen frames.

❍ Loop

This control loops the video clip until the stop button is pressed. If the loop control is pressed when the frame marker is between or at a bookmark, only the bookmark section will be looped.

❍ On Screen Information

A progress bar is provided at the top of the screen to indicate the relative position within the circular buffer of the currently displayed frame. This bar is also used to display bookmarks. In the same display panel as the progress bar is a numerical description of the frame number, the total number of frames in memory and the time of the current frame relative to the start of the memory.

28. Clip Select menu

This menu relates to selecting the video clip to be saved on the Compact Flash card.

Access: Home ▸ Playback ▸ Player ▸ Clip select

Options: Clip start Clip end I◀ ▶I Settings Save

- The CDU will display the playback images selected by the clip select controls

❍ Clip Start and Clip End Controls

The player controls are used to locate the start and end of the desired video clip and the Clip Start and Clip End controls are used to mark the chosen frames.

❍ Player Controls

The I◀ and ▶I controls will cause the player to immediately move either to the next bookmark or to the beginning/end of the memory.

❍ Settings

Quality Control

This control permits the user to apply JPEG compression to the image before it is saved onto the Compact Flash card. In this way, it is possible to increase the number of video images stored on the card and increase the speed of writing images to the card. The compression used is compatible with all versions of the Olympus *i*-SPEED, *i*-SPEED 2, *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF viewer and PC software. If the user wishes to encode the clip as a standard Windows .avi, the *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF PC software and viewer software provide this functionality.

NOTE

The maximum file size for an *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF movie is 2GB.

Skip Ratio

If a video clip has been captured at a frame rate which is too high, the resultant slow motion clip can be too large and may be too slow to use effectively. To counter this situation, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is able speed up the saved recording by missing frames when saving to the Compact Flash card, and can save every second frame, every third etc. This menu sets the ratio of saved to skipped frames.

Video processed

Select ON/OFF to apply video processing to the saved image.

❍ Save Control

If the start and end frames are selected as the same frame, the save control will cause the camera to save a single bitmap (BMP) or JPEG image to the card. If more than one frame is chosen, the camera will save a movie file to the card.

❍ On Screen Information

The Clip Select menu provides a progress bar to indicate the position in the buffer memory of the currently displayed frame as well as the start and end frame markers. This bar is also used to display bookmarks.

In the same display panel as the progress bar is a graphical representation of the available memory in the card, the total memory in the card and the quantity of memory required for the currently selected clip.

In a separate display panel is a numerical description of start frame number relative to the start of the camera's memory, the number of frames selected, the size of the chosen clip and the available free memory in the card.

NOTE

The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF High speed video camera produces video files in a proprietary format. The files have the unique file name extension .hsv. For example a file may be named "Test.hsv". These files may be played in the *i*-SPEED 3*, i*-SPEED FS, *i*-SPEED DF PC software supplied with the camera and also in the free *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF viewer software. Both of these pieces of software are also able to convert the file type to the Windows .avi format. The exact encoding provided by the *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF PC Software and the *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF Viewer Software depends on the CODECs installed in the user's PC.

29. Config menu

This menu makes available items relating to configuration of the camera. The 'More' options screen is shown in Section 35.

Access: Home ▸ Setup ▸ Config

Options: *Ethernet* *Date/Time* Monitor Standard *Camera ID* *Startup logo* *Battery status* *More*

•The CDU will display the splash screen logo

❍ Monitor standard

The composite video output connector (BNC) is able to provide either NTSC or PAL and this selection is made by this control.

30. Ethernet menu

When using multiple cameras in conjunction with the PC software, each camera will need to have a unique TCP/IP address. Every *i*-SPEED camera has a default address of 192.168.0.54. This control allows this address to be configured for each camera on the network. Once set, the TCP/IP address will be stored in the camera's memory.

The choice of address is dependent on the individual network being used and should be chosen by the network administrator. When the appropriate address has been set, the OK button should be pressed.

Access: Home ▸ Setup ▸ Config ▸ Ethernet

Options: (000) (000) (000) (000) (000) DHCP OK

❍ 000 Controls

Allows the user to choose the TCP/IP address from a list of preset values.

❍ DHCP Control

When a piece of equipment is connected to Ethernet, it is known to other equipment on the network by its TCP/IP address. This may be set manually (as above) or automatically using a system called DHCP.

If the network already has a DHCP server (most likely in pre-installed networks which include a server computer) then this may assign the camera a TCP/IP address. To enable this, set the DHCP to client.

If the network does not have a DHCP server, but contains other computer which are usually connected to a large network, and are therefore configured as clients, then the camera can act as the network's DHCP server and assign the other computers unique TCP/IP addresses. As a guideline, a network should either have A) 1 DHCP server and 1 or more clients or B) all equipment should have static IP addresses and DHCP is not used. This is an advanced topic and the user is advised to refer to his network administrator as appropriate.

- **OK Control**

  This control confirms the numerical entry just made and also returns to the previous menu.

31. Time / Date Setting menu

This menu permits the setting of the time and date of the on-board clock of the camera.

When the appropriate time and date have been set, the OK button should be pressed.

Access: Home ▸ Setup ▸ Config ▸ Time/Date

Options: Year Month Day Hour Minute Format OK

- **Year, Month, Day, Hour, Minute Controls**

  Allows the user to set the date and time.

- **Format Controls**

  Allows the user to choose the display format for the date and time.

- **OK Control**

  This control confirms the numerical entry just made and also returns to the previous menu.

32. Camera ID menu

The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera is capable of connection to an Ethernet network. It is possible to connect more than one camera and, whilst the cameras are uniquely identified by their TCP/IP address, it is sometimes useful to have a simple user settable ID tag which is kept with the downloaded video. This control allows the setting of this tag.

Access: Home ▶ Setup ▶ Config ▶ Camera ID

Options: OK Cancel Select Delete ◀ ▶ ▲ ▼

- **Select Control**

  Enters the character highlighted in the name bar.

- **Delete Control**

  Deletes characters from the name bar.

- **OK Control**

  Saves the entry.

- **Cancel Control**

  Returns to the previous menu.

- **◀ ▶ ▲ ▼ Controls**

  Navigates the character set.

33. Startup logo menu

After first stage boot, the camera displays the Olympus and *i*-SPEED 3, *i*-SPEED FS or *i*-SPEED DF logo on the CDU, and the user may add their own logo to this screen.

Access: Home ▸ Setup ▸ Config ▶ Startup logo

Options: Load Logo ON/OFF

❍ Load Control

The logo must be supplied to the camera on a Compact Flash card and should be a .bmp file with 300(h) x 200(v) pixels in 16.7 million colours (24 bit) and should be in a folder called logos\startup\ on the card. For the user's reference, the background colour of the rest of the splash screen is R:8 G:16 B:123.

❍ Logo ON/OFF Control

Turns the logo feature ON or OFF.

34. Battery status menu

This information page is provided for users who are interested in the status of the battery in their *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera, it is not essential to the operation of the camera.

Access: Home ▸ Setup ▸ Config ▶ Battery status

35. More menu

This menu makes available items relating to configuration of the camera.

Access: Home ▸ Setup ▸ Config ▸ More

Options: System restore Language Camera update Alignment grid TV Output Graphics IRIG

❍ System Restore

This function will permanently remove all of the settings entered by the user, including speeds, shutters, TCP/IP settings, user settings, name tags and so forth. The setup of the camera will be the same as when it was first shipped from Olympus. It may be considered as the next more severe reset after Home ▸ User Settings ▸ Default.

This function is included for users who wish to protect their security or who have made too many setting changes and wish to completely start again.

❍ Language

This control permits the user to set the language in which the menu's are displayed. The language of the information tiles and control value display is not changed.

❍ Camera update

This allows the user to update the camera software or firmware using a Compact Flash card.

❍ Alignment grid

This control allows a graphical grid to be overlaid on the live video image for alignment purposes. The value for the control can be either OFF, GRID-1 or GRID-2.

- **TV Output Graphics**

  This control allow the user to choose whether the graphics shown on the CDU are to be overlaid on the video image of the Video out (composite) and S-Video outputs.

- **IRIG**

  NOTE

  This function is only available on *i*-SPEED FS cameras.

  This control allows configuration of the IRIG functionality. Refer to "Chapter 8 Special features of the i-SPEED FS".

7.2 Measurement system

The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera has a built-in measurement system which is based on the principle of comparative measurement whereby measurement is achieved by entering the size of a known object in the image and then comparing this with the size to be measured.

The measurement suite is intended to give a good indication of relative object distance, speed and angle. However, due to the number of variable factors involved, no guarantee of measurement accuracy can be given.

The Measurement system is able to measure distance, speed and acceleration, as well as angle, angular velocity and angular acceleration.

Distance

The cursor is placed on the start point of the measurement and the Start Point button is pressed. As the cursor is moved, a line will be drawn from the cursor back to the start point and the distance will be given.

Speed

If the user also enters the player and moves back or forward by a few frames, then the cursor will now not only have moved some distance from the start point, but some time from it as well. Since speed is defined as distance moved over time, the measurement system will now provide a speed reading as well.

Acceleration

To measure acceleration, the user must measure a speed as above and then press the Accel Point button. Then the cursor must be moved by a few more frames and some further distance as before. This will result in a second speed measurement, starting at the Accel Point and ending with the new cursor position.

Acceleration is defined as the change of speed over time. For the change in speed, the measurement system compares the two speeds measured from Start Point to Accel Point and from Accel Point to the current cursor position. To measure each of these speeds, the user shifted by some frames each time and the measurement system compares the centre times of each of these shifts to obtain the time difference.

Angle, Angular Velocity, Angular Acceleration

These functions operate in exactly the same manner as the distance measurements, except that the user must first define an Origin Point which will be used as the centre of the rotation.

IMPORTANT: The entire reference measurement and the entire measurement of interest must be coplanar, in a plane orthogonal to the axis of the camera.

This means that for distance and speed measurements, the scene must contain an object whose size is accurately known. Also, this object must be the same distance from the lens as the object being measured.

Furthermore, the start and end points of the known measurement and the start and end points of the measurement of interest must all be the same distance from the camera. For angle and angular velocity measurements, the origin, start and end points of the measurement must all be the same distance from the camera.

The accuracy of measurement depends on the conditions above being fulfilled and on the skill of the operator in placing the on screen cursors accurately.

This system does not take account of any geometric distortion added by the user's lens.

1. Measure menu

This is the home or start-up screen of the measurement system. Before the system is used, set the Linear/angular units of measurement and calibrate the system by measuring an object of known dimensions using Linear CAL.

Access: Home ▸ Playback ▸ Measure

Options: *Linear CAL* *Linear units* *Linear measure* *Angular units* *Angular measure* *Colour*

•The CDU will display the playback image

❍ Linear units

Linear units of measurement are shown below.

Distance	m	yards	feet	inches	cm	mm	
Speed	mph	km/h	km/s	m/s	ft/s	in/s	cm/s
Accel	m/s^2	ft/s^2	in/s^2	cm/s^2	mm/s^2		

❍ Angular units

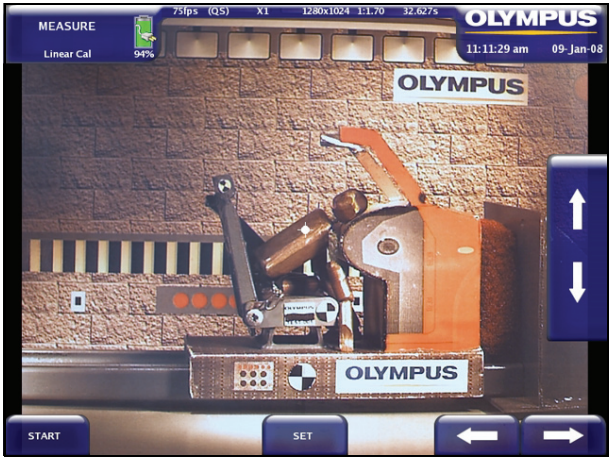
Angular units of measurement are shown below

Angle	grad	rad	deg		
Angular velocity	rpm	rps	grad/s	rad/s	deg/s
Angular accel	rpm/s	rps/s	$grad/s^2$	rad/s^2	deg/s^2

2. Linear Calibration menu

Access: Playback ▸ Measure ▸ Linear CAL

Options: Start Set ◀ ▶ ▲ ▼



- **◀ ▶ ▲ ▼ Controls**

  These controls allow the user to move the measurement cursor.

- **Start Control**

  Position the cursor as described above and press Start to mark the start of the measurement for calibration.

Set Control

Position the cursor as described above and press Set to mark the end of the known distance which is used for calibration. The following screen will be displayed where the known measurement should be entered using the appropriate controls. Confirm the unit of measurement is correct and press OK. The system returns to the measurement screen.

3. Colour menu

Access: Playback ▸ Measure ▸ Colour

Options: Line colour Line shadow Text colour Text shadow

- **Line colour / Text colour**

  The line and text colour controls allow the user to select the colours of the on-screen cursor and text to improve legibility against different backgrounds.

- **Line shadow / Text shadow**

  These controls are used to set line/text shadow ON or OFF.

4. Linear measurement menu

Access: Playback ▸ Measure ▸ Linear measure

Options: Start point Accel point Player Save ◀ ▶ ▲ ▼

•The CDU will display the playback image

- **Start point Control**

  This control marks the start of the measurement.

- **Accel point Control**

  This marks the middle point in an acceleration measurement. First, the user must complete a speed measurement by marking a start point, moving the cursor some distance and moving the player some frames. The Accel Point button is then pressed. The user must then move the cursor by some more distance and the player by some more frames, in a similar manner to the speed measurement just completed. The measurement system will then be able to calculate 2 speeds. The acceleration is calculated as the difference between the 2 speed measurements divided by the difference in time between the central time of each measurement.

- **Player Control**

  The player is presented here to allow the measurement of speed and acceleration, by permitting the user to move to a different frame for the middle and end points of the measurement.

Save Image

This control causes an image to be saved to the Compact Flash card. The user is offered the opportunity of creating a meaningful name for the saved image. The image will be saved exactly as it is seen on the CDU, with a resolution of 800 x 600 pixels, regardless of sensor resolution. Any image processing selected in the Picture menu will also be included. The saved image will be in bitmap format only.

◄ ► ▲ ▼ Controls

These controls allow the user to move the measurement cursor.

5. Angular measurement menu

Access: Playback ▸ Measure ▸ Angular measure

Options: Origin point Start point Accel point Player Save ◀ ▶ ▲ ▼

- **Origin Control**

  This control marks the origin or axis of rotation for the measurement of angle and angular velocity.

- **Start Control**

  This control marks the start of the measurement.

- **Accel point Control**

  This marks the middle point in an angular acceleration measurement. First, the user must complete an angular velocity measurement by marking an origin point and a start point, moving the cursor some distance and moving the player some frames. The Accel Point button is then pressed. The user must then move the cursor by some more distance and the player by some more frames, in a similar manner to the angular velocity measurement just completed. The measurement system will then be able to calculate 2 angular velocities. The angular acceleration is calculated as the difference between the 2 angular velocity measurements divided by the difference in time between the central time of each measurement.

- **Player Control**

  The player is presented here to allow the measurement of angular velocity and angular acceleration, by permitting the user to move to a different frame for the middle and end points of the measurement.

- **Save Image**

  This control causes an image to be saved to the Compact Flash card. The user is offered the opportunity of creating a meaningful name for the saved image. The image will be saved exactly as it is seen on the CDU, with a resolution of 800 x 600 pixels, regardless of sensor resolution. Any image processing selected in the Picture menu will also be included. The saved image will be in bitmap format only.

- ◀ ▶ ▲ ▼

  These controls allow the user to move the measurement cursor.

Chapter 8 Special features of the *i*-SPEED FS

8.1 IRIG time system

The *i*-SPEED FS is designed to allow operation using the IRIG timing standard. The IRIG functionality within *i*-SPEED FS is split into three areas, each of which may be configured to the users requirements, these are:

- IRIG mode and cable delay
- IRIG synchronisation
- IRIG video time stamping

These functions are explained below.

1. IRIG time system

This menu provides rapid access to the most commonly used functions.

Access: Home ▶ Setup ▶ Config ▶ More ▶ IRIG

Options: Mode Cable delay Cable delay calculator

❍ Mode

The IRIG mode of *i*-SPEED determines the function of the camera's internal IRIG clock system. When IRIG timings are enabled the current IRIG time is displayed under the real time clock in the top right hand panel. The status of the IRIG timings is always indicated next to the displayed IRIG time by a traffic light system as follows:

Light is off (grey) - Status Uninitialised. An IRIG signal has not been detected yet.

Light is yellow - Status Warning. An IRIG signal has been detected but is not considered 'trustworthy'. This could be for either of the following reasons.

IRIG has only just been connected or enabled and the camera has not yet had sufficient stable input to lock its internal IRIG clock.

or...

IRIG has previously been locked but the incoming IRIG signal has now been detected as invalid - either the signal has just been lost or an invalid time code has been received.

Light is green - Status Locked. IRIG is detected and good.

Light is red - Status Error. IRIG has previously been locked but is now invalid. IRIG time is now calculated from the last received valid IRIG time code and the camera's internal IRIG clock.

NOTE

The *i*-SPEED FS constantly monitors the incoming IRIG signal and averages out any jitter of the 1kHz carrier. Several seconds of good IRIG signal are required for this system to reach optimal operation. The user should allow at least 1 minute after connection of the IRIG signal before undertaking qualification tests or critical usage.

Momentary interruptions of the IRIG signal will be automatically recovered from and every frame will be tagged with the status of the IRIG timings at the start of its exposure according to the regime above. Thus the IRIG status will show as Locked>Warning>Locked for a brief interruption and Locked > Warning > Error > Warning > Locked for a longer interruption. Unrecovered loss of the IRIG signal will be flagged as Locked > Warning > Error where the first frame with a status of Warning is the first frame whose exposure started after loss of the IRIG signal.

NOTE

The longer an interruption of the IRIG signal lasts and the lower the quality of the IRIG signal as received at the camera, the longer it will take for the internal averaging system to recover optimal accuracy.

The status of the IRIG timing is also identified in the saved .irg file and on recorded video - see IRIG video time stamping section below.

The Auto Detect setting enables the camera's internal IRIG clock when a valid IRIG signal is detected on the IRIG input. Until an IRIG signal is received there are no IRIG timings calculated or displayed. The timing status Uninitialised will never occur. This is the default setting.

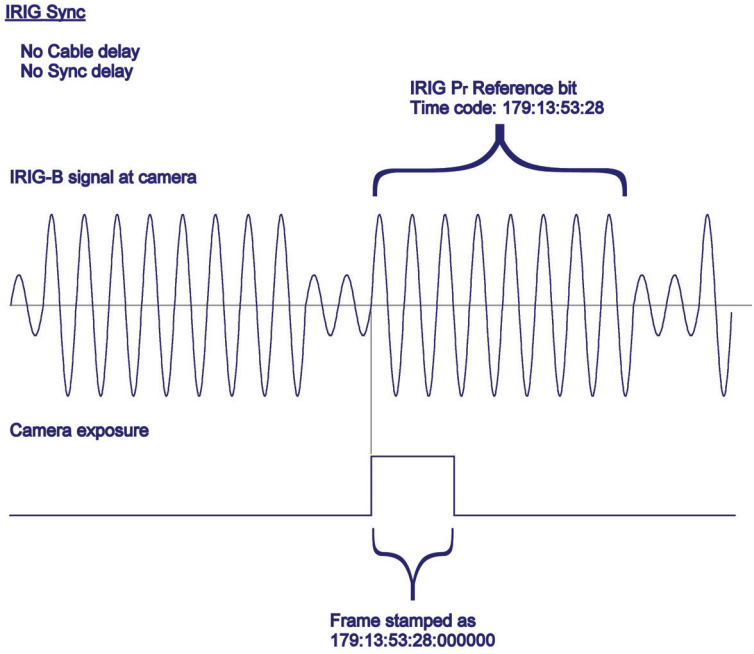
The On setting forces the IRIG timing system to be enabled whether or not a valid IRIG signal is detected on the IRIG input. If a valid IRIG has not been received since power on the displayed IRIG time will show all zeros and the timing status will be Uninitialised. If there has been a valid IRIG signal received previously the calculated IRIG time is based on the last received time code and the timing status will be Error until a valid IRIG signal is re-connected.

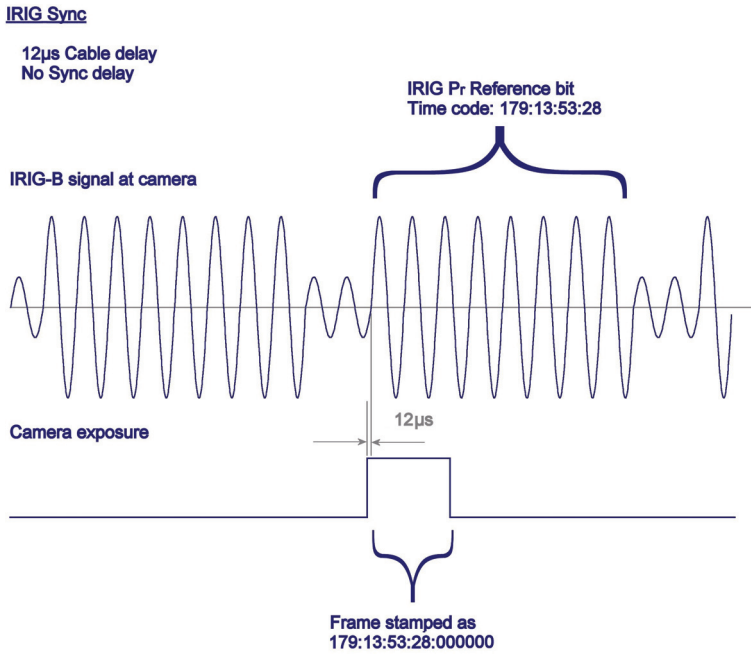
The Off setting disables the camera's IRIG timing system.

2. Cable delay menu

Access: Home ▸ Setup ▸ Config ▸ More ▸ IRIG ▸ Cable delay

All electrical signals experience a propagation delay when travelling. This menu provides a way to compensate for the cable delay so that the IRIG time at the generator is the same as that time stamped on each frame. This offsets the IRIG exposure synchronisation (if used), so that the time stamp for multiple cameras is the same regardless of cable delay. To clarify the effect of this setting, consider the following timing comparison diagrams.


IRIG Sync
No Cable delay
No Sync delay
IRIG Pr Reference bit
Time code: 179:13:53:28
IRIG-B signal at camera
Camera exposure
Frame stamped as
179:13:53:28:000000


IRIG Sync
12µs Cable delay
No Sync delay
IRIG Pr Reference bit
Time code: 179:13:53:28
IRIG-B signal at camera
12µs
Camera exposure
Frame stamped as
179:13:53:28:000000

This screen allows a numeric input of the required cable delay offset in µs. To cancel a previously entered cable delay, enter a new delay of 0.

3. Cable delay calculator menu

NOTE

The user is urged to validate any assumptions made about IRIG cable delays.

Access: Home ▸ Setup ▸ Config ▸ More ▸ IRIG ▸ Cable delay calcualtor

Most 50Ω co-axial cables have a propagation delay of approximately 4ns/metre. If the user considers this assumption valid in their particular application, then this menu provides an easy means of entering a cable delay offset by entering the cable length from the IRIG generator. Choose the desired length units, enter the cable length and select Calculate to see the cable delay. The Apply button can be used to assign the calculated cable delay to the camera.

4. IRIG Sync mode

This menu provides access to configure the synchronisation of the camera to the IRIG timing signal.

Access: Home ▸ Setup ▸ Trigger & Sync ▸ Sync

Options: Sync edge Sync mode IRIG sync speed IRIG sync delay

As well as receiving and recording IRIG timings, *i*-SPEED FS cameras can also be synchronised to the incoming IRIG signal. To enable IRIG sync, set the Sync Mode setting to IRIG, this then enables the IRIG sync settings for speed and delay.

NOTE

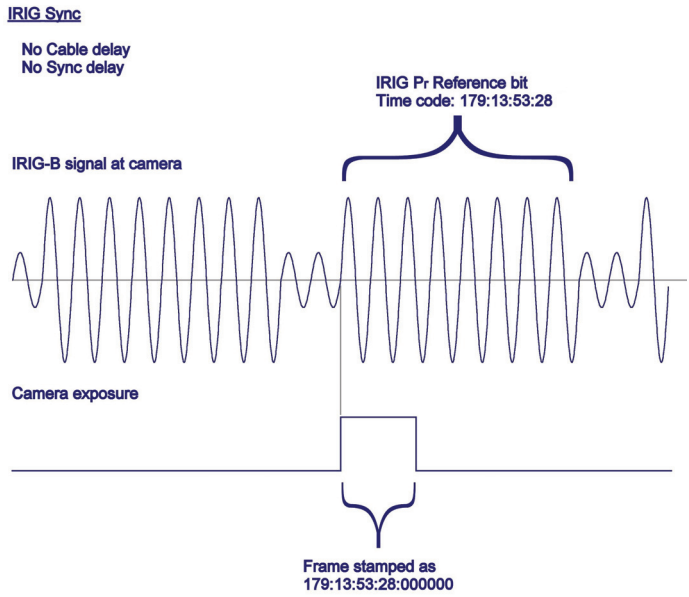
If the Sync mode is not set to IRIG then the frame IRIG time stampings are still valid but the frame exposure is not synchronised to the IRIG signal.

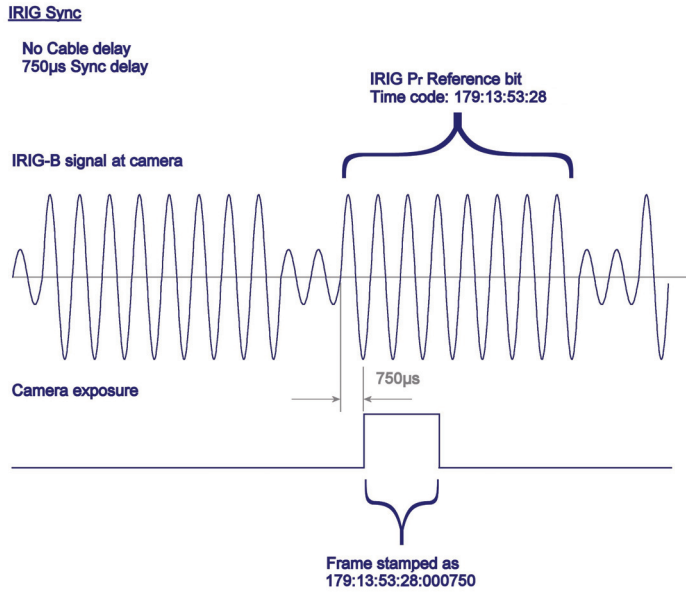
❍ IRIG Sync Speed

The IRIG standard signal only contains time/date reference information and therefore the user must set a desired frame speed to be synchronised as this can not be detected from the IRIG signal. The desired IRIG Sync Speed can be set by either selecting a value from the preset IRIG Sync Speed list or manual entry down to 1fps resolution. The control mode of the speed selection may be switched in Home ▸ Setup ▸ Control Mode ▸ IRIG Sync Speed.

❍ IRIG Sync Delay

By default IRIG synchronisation on the *i*-SPEED FS aligns the start of frame exposure to the rising zero-crossing of the IRIG 1PPS Pr reference bit. If desired the user can enter an offset in µs to shift the start of frame exposure relative to the IRIG 1PPS signal. This offsets the IRIG exposure synchronisation and the time stamp. To clarify the effect of this setting, consider the following timing comparison diagrams.


IRIG Sync
No Cable delay
No Sync delay
IRIG Pr Reference bit
Time code: 179:13:53:28
IRIG-B signal at camera
Camera exposure
Frame stamped as
179:13:53:28:000000


IRIG Sync
No Cable delay
750µs Sync delay
IRIG Pr Reference bit
Time code: 179:13:53:28
IRIG-B signal at camera
750µs
Camera exposure
Frame stamped as
179:13:53:28:000750

5. IRIG video time stamping

When saving a clip that was recording with the IRIG timing system enabled, a complimentary .irg file is saved that records each frame number, its IRIG time and IRIG timing status.

When operated with IRIG timing enabled the permanent text system can be used to destructively overlay each frame of saved video with its associated frame number, IRIG time and IRIG timing status. Refer to Chapter 7 Embedded Software Reference (CDU) for details of the permanent text feature.

The status of the IRIG time will also be indicated in the .irg file and in permanent text by a prefix of ✓ for Locked, ? for Warning, ✗ for Error, or - for Uninitialised.

8.2 Optimize mode FS

For *i*-SPEED FS selecting optimize mode FS (fast shutter), which may be accessed from Home>Start>Optimize, allows the use of higher frame speeds and faster shutters than other cameras in the *i*-SPEED range. In the FS optimize mode the maximum frame speed is 1,000,000fps and the minimum shutter time is 0.2µs.

Chapter 9 Understanding the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has been designed with ease of use in mind and all the functions of the camera are accessed via clear and descriptive menus. Every effort has been made to ensure that the menus are intuitive.

High speed video however, is a complex subject in itself and several of the functions of the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF are necessarily complex. Reading the following section will provide the user with sufficient knowledge of these areas to begin to understand the menus themselves. A detailed description of the menus is given earlier.

❍ Speed, Resolution, Record Time, Economy Modes

In order for the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF to capture frames of video at high speeds, a specialised sensor is used. In spite of this, there is a limit to the number of pixels the sensor can process per second, and this sets a limit on the frame speed of 2,000 frames per second (fps) for a full resolution (1280 x 1024) image.

If faster operation is required, the number of pixels per frame must be reduced, and this is accomplished by reducing the active area of the sensor. This function is called windowing and can increase the maximum frame speed of the *i*-SPEED TR to 10,000fps, the *i*-SPEED 3 to 150,000fps, *i*-SPEED FS to 1,000,000fps and *i*-SPEED DF to 300,000fps. The on-board zoom engine is used to automatically compensate for the reduction in image size.

The camera contains electronic memory to hold the video images as they are captured and this has a specific size, which is dependent on the model chosen. The memory is therefore capable of holding a fixed number of full resolution images and there is a clearly defined maximum recording time at 2,000fps.

If the frame rate is reduced below 2,000fps, the available record time will increase because the images are arriving less frequently. If the frame rate is increased above 2,000fps, the available record time will not change much because, although the images are arriving more often, the image size is reduced and the two effects tend to offset each other.

Under some circumstances, it is desirable to record for a longer time than the memory permits. It will be noted however, that some high speed events are primarily horizontal or vertical in nature and so it is sometimes found that the edges of the screen contain no useful video information. This fact is used for the economy modes, which reduce the active area of the sensor below the size suggested by the frame speed. This reduced image size increases the number of images which may be stored in the memory and thereby the record time is increased.

Several economy modes are available. Wide modes remove the top and bottom edges of the image, tall modes remove the left and right edges and square modes remove the top, bottom, left and right edges of the image. In square mode, the internal zoom engine is again used to compensate for the reduced image size.

The *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF provide a further manual mode and the user may choose the size of the window.

There is a further trade-off associated with frame speed and this is discussed below.

❍ Shutter, Speed, Sensitivity

The sensor operates by capturing light, converting it to an electronic facsimile of the optical image and supplying the memory with the image while the cycle begins to repeat. The period during which light is captured is called the “integration time”, “exposure time” or “shutter time”. The shutter time is normally equal to the maximum time available during the frame, called the “frame period”.

If the scene contains a very fast moving object, the object may move an appreciable distance during the frame period and this will cause the object to appear blurred. This “motion blur” is sometimes undesirable, so the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is able to reduce the shutter time to a fraction of the frame period and this causes the object to be “frozen” in each frame. The shutter time can be measured relatively as the ratio between frame period and shutter time, e.g. 10x means that the shutter is open for 1/10 of the frame period, or as an absolute time in µs.

Reducing the shutter time however, reduces the amount of time the camera spends gathering light and the image will become dimmer. For this reason, increasing the shutter setting will normally require the addition of extra light to the scene.

When in relative shutter mode, this effect is found when the frame speed is increased. The available shutter time is reduced because the frame period is reduced - the faster the frames are taken, the less time is spent on each one. As a result of this, increasing frame speed will normally require the addition of extra light to the scene.

❍ Shutter, Speed, Sync mode

As discussed above, the speed limit of a high speed video camera is a result of the frame rate multiplied by the number of pixels in the image (the resolution) and windowing is used to let the user choose the balance between these specifications in their application. This balance is applied differently for different sync modes.

In Auto sync mode the maximum frame speed is set by the initial frequency of the incoming sync signal. This determines the resolution of the recorded frames and the maximum duration of shutter. The user may preset a shorter duration shutter if desired.

Prior to selecting Random Snapshot sync mode the user must set the desired resolution of the recorded frames by selecting a corresponding maximum speed. This should be set to at least 5% above the maximum expected input sync frequency. The shutter should also be set to time (absolute) mode and a shutter time (in µs) specified. The resolution and the shutter duration determine the maximum speed at which random snapshot frames can be captured. Any sync signals that are received at a faster rate than this maximum will be ignored. If the shutter mode is set to x (relative) prior to entering Random Snapshot sync mode the shutter will be set to an absolute time corresponding to the shutter x previously selected at the maximum chosen frame speed.

i-SPEED TR cameras do not have Random Snapshot sync mode.

❍ Dynamic Range

The human eye has an extraordinary ability to see dark and bright objects simultaneously. The classical illustration of this is a plant on a windowsill. The eye can see the plant and the view through the window simultaneously. Ordinary video cameras are less capable and can only produce images of one or the other. Either the plant will be a featureless black silhouette and the view through the window will be visible or the plant will be visible and the view through the window will be a featureless white sheet.

The level of ability to see light and dark simultaneously is called dynamic range.

The *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF's image sensor is capable of increasing its dynamic range by detecting light in a non-linear fashion. This permits each pixel to individually reduce its sensitivity with increasing light. This effect allows the sensor to gather image features in very bright and dark areas simultaneously and this process is known as "dynamic range extension".

This system does however, reduce the camera's ability to detect colours, so use of this feature in a colour camera may compromise colour rendition.

i-SPEED TR cameras do not have this feature.

❍ Internal Memory, Circular buffer

When in record mode, the camera continuously stores frames in its internal memory. That memory is configured in a circle so that, once the memory is full, each new frame replaces the oldest stored frame. In this way, the camera keeps a rolling history of the scene it views and this process can continue indefinitely. This configuration of the memory is called a "circular buffer".

Once the desired event has occurred, the camera may be stopped by pressing a menu button or raising a trigger event as discussed below.

❍ Trigger

As mentioned above, the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF records video in a circular buffer and can do so indefinitely. At some point, however, it is necessary to stop the recording process in order to preserve the data in the memory.

The method of stopping the camera is highly important as it is this which guarantees the capture of the event in question. There are three methods of stopping the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF. The first is a button press in the menu system and this immediately stops the record process, so that the memory contains the history prior to the button press.

The second method is to use an external electrical trigger, which causes the camera to stop after a user-settable delay. By permitting the camera to record for a brief time after the trigger, some history before the trigger and also some future after the trigger are preserved in the memory. In this way, the trigger may occur in the middle of the event of interest and yet the camera can still capture the whole event.

The delay between the trigger event and the cessation of recording is controlled by a frame counter known as the trigger counter. The length of this count is controlled by the menu system and is expressed as a percentage of the total available record time of the camera's memory.

The counter value is described from the viewpoint of the final recorded video clip, so that a setting of 0% sets the counter to delay for the entire length of the circular buffer. In this way, the trigger event will appear at the beginning of the video clip. Similarly, a setting of 100% will cause the camera to stop immediately a trigger is received, and this will place the trigger event at the end of the recorded video clip.

Since the trigger is an electrical signal, the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF may be set to wait for either the rising or the falling edge of the trigger pulse.

The third method of stopping the recording in the Olympus *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF is video trigger, which is similar to normal trigger in operation, but which derives its trigger signal from observing the video image. A description follows after ROC, BROC below. *i*-SPEED TR cameras do not have this feature.

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has two extensions to the normal trigger operation described above. These are called Record On Command (ROC) and Burst Record On Command (BROC) and a description of these follows.

❍ ROC, BROC

Record On Command (ROC) and Burst Record On Command (BROC) are extensions of the normal trigger function of the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF. Once Recording mode is selected in ROC mode, the camera only records video into the memory while the trigger signal is true (active low). By judicious use of the trigger connection (e.g. dextrous use of the supplied trigger switch) the camera may record several short bursts of video into the memory buffer.

For the purposes of ROC and BROC, the memory is not treated as a circle, but is regarded as a straight line with a defined start and end. When the memory is full, no further recording is possible. A progress indicator is provided.

A facility is provided to erase video bursts from the memory in case an error is made in the use of the trigger switch. A further facility is provided to erase the entire memory.

BROC is an extension of ROC, in that a trigger edge (rather than an active level) will cause the camera to record video for a pre-defined time. The length of time that the trigger signal is active is ignored. This function is especially useful for unattended operation when several short events are likely to occur. The burst time is settable in the menu system.

❍ Video Trigger

In some circumstances, such as unattended operation or scenarios when the event of interest will occur randomly but after a long wait, it is necessary to have an automatic trigger. In some cases, electrical or mechanical connection to the high speed event is not possible, and in these cases it is desirable for the camera to trigger automatically on a change in the video image. This function is called Video Trigger. The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF provides a fully automatic video trigger with 3 configurable regions of interest (ROI).

When setting up, the ROI is shown as a rectangle on the CDU, which the user may re-size and position as required. The rectangle is not included in the captured video. The three ROIs may be turned on and off and configured independently of each other. A trigger from any of the active ROIs will trigger the camera.

When the video trigger is activated, the user will see a bar graph at the top of the CDU screen. The graph will contain a white line and a green box. In steady state, the end of the line will be in the middle of the box. The line represents the average brightness of the image inside the ROI. The box displays the sensitivity of the video trigger, wider means less sensitive. If the average brightness changes sufficiently for the line to move outside the box, a trigger event will occur, and the green box will turn red.

In order to ease setup and to account for small variations in ambient brightness, the sensitivity area is automated. It will slowly move to lower and higher brightness (left to right) as the average brightness in the ROI changes. In this way, slow changes of light will be ignored by the video trigger, but sudden changes inside the ROI will cause a trigger event. The sensitivity of the video trigger, and hence the width of the sensitivity area may be changed as appropriate.

The user is advised to perform several trial runs while setting up the video trigger. It is not necessary to set the camera to record, since the sensitivity area of the graph will turn red when a trigger occurs.

It is best practice to set the ROI to encompass the smallest area which will see the most sudden and complete change in brightness. It must be remembered that a change in detail within an area will not cause a trigger. As an example, consider a black disc which contains a white quadrant. If the ROI is set to encompass the entire disc, the average brightness will be independent of the position of the disc and the system will never trigger. Instead, the user should set the ROI to be about a third of the radius of the disc and place it just inside the circumference. In this way, the ROI will usually contain black but will rapidly turn white when the disc rotates by a certain amount.

It must also be remembered that the Video Trigger operates at a sample rate of 30Hz. If the disc in the example above rotated extremely rapidly, the trigger would operate incorrectly. It should also be remembered, therefore, that the trigger event is likely to be raised some time after the change in the ROI. The typical delay is 30 to 60 milliseconds.

It is advisable to set the sensitivity to somewhat below the practical maximum. If sensitivity is too high (smaller box size) the trigger may fire falsely. If the sensitivity is too low (large box size), the trigger may not fire when the event occurs. Again, the best advice is to do several trial runs.

i-SPEED TR cameras do not have this feature.

❍ Sensor, FPN, FPN Calibration

The image sensor used in the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera is a CMOS chip and, like all CMOS imagers, it has the property of introducing fixed pattern noise (FPN) onto the image. Most HSVC manufacturers provide some form of correction to remove the FPN and the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF provides an automatic correction system which is configured during manufacture.

This is sensitive to the enhanced gain function and takes a second or two to load each time the sensitivity is changed.

❍ White Balance

The human eye automatically adjusts its colour processing in order to make white objects look “white” in spite of varying ambient lighting colour. When viewing video on a monitor, however, the eye judges white based on the ambient around the monitor, not on the ambient around the camera. For this reason, a colour camera must also adjust its processing to compensate for the ambient lighting and configure its output to produce the electronic version of pure white (red = green = blue) when a white object is viewed. In this way, the camera can render white objects as white on the monitor, in spite of ambient light coloration. This function is called white balance.

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF provides two types of white balance, pre-set and automatic. Several preset white balance settings are provided, based on light source technologies found in the Olympus range of industrial light sources.

The automatic function relies on the user placing a pure white reference (sheet of paper etc.) if front of the camera, completely filling the field of view and then pressing the WB Set button. When this is done, the camera will sample the reference and reconfigure its processing electronics to render this as pure white. The reference must not be removed until the white balance is complete, so an on screen message shows the status of the white balance process.

If the automatic white balance function fails, the iris should be reduced slightly to prevent saturation. The luminance histogram function is useful to assist with this process.

❍ Lighting

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has been designed to remove most of the difficulty associated with taking high speed video shots, but two areas of critical importance still remain, lenses and lighting. In many cases, most of the time taken when working with the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF will be used in setting up the lighting, framing the shot and choosing the correct lens.

Earlier sections of this document have described how the shutter time and speed setting of the camera dramatically increase the requirement for light. The result of this is that most high speed video applications require a large amount of lighting and this is a common theme in the high speed video industry. As a rough guide, most indoor shots require 100 to 1,000 watts of additional lighting. This is traditionally provided by shining a few high power spot lights on the target scene but, for smaller targets, the Olympus range of industrial light sources and light guides provide ideal illumination.

Simply providing a large wattage of light is not suitable for most applications. It is usually necessary to carefully focus and target the light, so general purpose floodlights are not normally useful in HSV work.

An illustration is given from the experience of the *i*-SPEED development team. A car parts manufacturer wished to view a rapid movement in the mechanism of a prototype seatbelt reel. The scene was illuminated with several 1,000 watt garden floodlights, but this was sufficient for only a few hundred frames per second. The lighting was removed and replaced by a single specialised 500 watt spotlight and this permitted operation at 1,000 fps. When faster operation was required, the spotlight was augmented by an Olympus Industrial light source and liquid light guide and this increased the operating speed to 4,000fps.

This example is included to show that the quantity of light is significantly less important than the concentration of light. Olympus representatives are able to supply specialised lighting which has been selected to be suitable for most high speed video applications.

❍ View Finder

In contrast with some inferior products, the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera presents the live image on the CDU or monitor screen at all possible times. Some menus do require the image to be obscured, however. Also, the playback screen is used to display the contents of the memory buffer, rather than a live image. During the live view and the record process, however, the screen will display a live, colour, real time image, updated at 30 frames per second.

❍ Lenses

The choice of lens can make a dramatic difference to the video images obtained.

Choosing the lens must begin with the focal length, which is expressed in mm. A lens with a large focal length would normally be chosen when a small area is to be viewed or the camera is to be a long distance away from the scene, because a longer focal length means a greater magnification. This type of lens has the disadvantage of reducing the apparent distance between objects which are arranged axially with the camera. This is called foreshortening. Lenses with long focal lengths also tend to have a smaller maximum iris setting (higher f number) and are therefore dimmer than long focal length lenses.

A lens with a short focal length is chosen when a wide area is to be viewed, or the camera is to be placed near to the scene. Lenses with a very short focal length have the disadvantage of distorting the perspective of the image and this is called barrel distortion.

Normal lenses have a controllable iris or aperture. The iris controls the amount of light available to the camera. The higher the f number, the less light the lens transmits. Increasing the number by 1.4 times (e.g. from f/4 to f/5.6), is called 1 stop and halves the light throughput.

There is a secondary effect of reducing the iris (increasing the f number) and this is an increase in the depth of field. This means that the lens is more able to focus on close and distant objects simultaneously, so a small iris setting is advantageous.

This is in conflict with the normal HSV requirement for as much light as possible, especially at high speeds and fast shutter times. Probably the greatest art in lens set-up is striking a balance between getting all objects in the scene into focus and having a

bright enough image. It is advisable in general to operate with a smaller iris (higher f number) and add more light.

It is not possible to specify an ideal lens, because photography is dependant on the object being photographed, but an “average” lens for the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF would have a focal length of 50mm and an iris range of f/1.4 to f/22.

❍ Motion JPEG Compression (not MPEG)

The compressed movie format of the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF relies on JPEG compression and uses a proprietary motion JPEG format which has the unique file name extension .hsv. For example a file may be named "Test.hsv". These files may be played in the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF PC software supplied with the camera and also in the free *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF viewer software. Both of these pieces of software are also able to convert the file type to the Windows .avi format. The exact encoding provided by the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF PC Software and the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF Viewer Software depends on the CODECs installed in the user's PC.

The most common compression technique for moving images is MPEG, as is used in DVD and digital TV. The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF does not use this format as it is not suitable for high speed video. This is because MPEG relies not only on compressing the image, but also compressing the motion, by only saving the changes between frames. This is called inter-frame compression and works by extracting the motion from the video and estimating its impact on the image. The decompressed video, therefore, is partly built on statistical estimation of motion. As a result of this, many high speed video users find that the very thing they wish to analyse - motion - is badly distorted by MPEG.

NOTE

The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera is capable of operating at many different resolutions. The JPEG compressor, however, is only capable of handling images which are integer multiples of 16 pixels high and wide. Therefore, if the resolution is not an integer multiple of 16 x 16, the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF

adds a black border to the right hand and bottom edges of the image to make up the size to an integer multiple of 16 x 16. This border will only be visible when a file is saved to the CF card and then played in a computer.

❍ JPEG Compression

Although the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF contains a state-of-the-art microprocessor system, there are still limitations on the speed with which data can be written to a Compact Flash card or an Ethernet channel. Even the most modern memory cards have a limited capacity, and the amount of video that can be saved in any one test session is often restricted.

In order to overcome these two issues, the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF contains a piece of electronics called a JPEG Compressor. This device can take live frames of video and compress them from their raw “bitmap” format into a more tightly compacted format called JPEG (named after the Joint Picture Expert Group who invented the format and techniques involved)

The term “bitmap” means that for every pixel in the image, three numbers are stored in the file, one each for red, green and blue. In this way, every pixel is fully described and the storage of the image is completely accurate to the original. On the other hand, this is extremely wasteful. If this page were to be stored as a bitmap, the file would contain a large amount of duplicated information, because there is a large amount of pure flat white to be stored.

JPEG compression involves breaking the image into 8 x 8 or 16 x 16 pixel blocks and examining each block in turn to see if there is any redundant information. Once this has been established, a decision can be made about exactly what constitutes redundancy, and so the compression ratio may be varied. (For the more technical reader, this process is based on Discrete Cosine Transformation followed by Huffman Encoding.)

Naturally, to achieve a higher compression ratio, some information may be omitted, and although only the least relevant information is omitted, some loss of image data does occur. This is normally seen as faint speckles around highly detailed sharp edges in the image. The higher the compression rate, the more loss occurs. As a guideline, 7:1 compression produces images which are basically indistinguishable from the original. 15:1 (the most common ratio for

digital cameras) produces losses which are only visible by someone who is deliberately looking for artefacts under high zoom. 65:1 produces artefacts which are occasionally visible, but do not detract from the appearance of the image.

❍ *i*-FOCUS

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF High Speed Video Camera incorporates a high resolution video sensor which has greater resolution than many display devices. Use of a lower resolution display makes it difficult to achieve the optimum focus because the display will not show the finest detail in the image. Along with this, focussing a camera is inevitably a subjective process and is therefore open to user interpretation and inaccuracy.

To assist in the focussing process, the Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF incorporates a newly designed feature called *i*-FOCUS. This image processing function analyses the image from the sensor, detects the state of focus and presents the user with a specially modified view of the image. The basic picture is displayed without colour and with reduced brightness. Items in sharp focus are then highlighted in red, less focussed items are shown in yellow, then green, then blue. Out-of focus items are not highlighted.

With this feature, the user can easily locate the area of interest in the image and then adjust the focus ring of the lens to achieve the maximum possible focus in these areas, or achieve a compromise of focus in multiple areas of interest.

❍ Optimize

The Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF High Speed Video Camera contains a custom designed CMOS image sensor and this is operated by highly complex drive electronics. The electronics has been optimised to give the highest quality image and yet still allow high speed operation. It is possible, however, to re-program the drive electronics to operate the sensor with different optimisations.

If the HQ (highest quality) option is selected in the Optimize menu, the sensor drive is configured to provide the highest quality images possible.

If the QS (quality but with improved speed and shutter) option is selected in the Optimize menu, the sensor is operated at higher speeds and permits shorter shutter times, but this can reduce the image quality a little under certain conditions.

i-SPEED FS cameras have an additional optimize option, FS (Fast Shutter). If this option is selected in the Optimize menu, the sensor is operated at its highest speeds and permits the shortest shutter times, but again this can reduce the image quality a little under certain conditions.

i-SPEED DF cameras have an additional optimize option, SIF (Shortest Inter-Frame time). This allows use of the least delay between frames for use in PIV applications in conjunction with the DF sync mode. Use of the Double Frame sync mode is available only via PC control. A Software Development Kit (SDK) is available for customers who wish to use this functionality. Please contact Olympus for further information.

i-SPEED TR cameras do not have this feature.

❍ Gamma and Gamma with Tru-color Processing (GTP)

The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF image sensor has a linear light to output conversion function. This means that as the light is doubled or halved, so the output digital level or signal voltage is also doubled or halved. In most circumstances, this is the optimum arrangement, but there are cases where an image contains a large disparity between light areas and dark areas.

In these circumstances, it is often found that the user sets the exposure of the camera to allow bright areas to be sufficiently visible, without excessive image saturation (blank peak white areas). In these circumstances, details in the dark areas are lost because they fade into the blackness. In truth, these details are often still present in the image, but some enhancement is required to make them visible.

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF provides several image enhancement functions, including brightness, contrast, colour and sharpness. In the circumstances discussed here, however, Gamma adjustment is often the best choice, since it allows the darker areas to be more visible and does not flood out the light areas. This is achieved by adding a non-linear function into the image processing, which adds more gain to the dark areas and reduces gain in the light areas on a pixel by pixel basis. The effect appears very natural because it mimics the operation of the human eye. The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF provides a variable gamma function.

Gamma, however has a drawback in that it reduces the saturation of colours in the image - it makes the colours look pale. The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has a function that can reduce this effect, Gamma with Tru-color Processing, or GTP. This function is able to boost colour in areas where they have been reduced by the natural operation of Gamma. The function is menu selectable because it is not always appropriate. As a guideline for the more purist user, there is no definitive right and wrong with the use of Gamma or GTP, it is best to decide by looking at the image and judging what looks most natural.

❍ Permanent Text and Logo

In some circumstances, it is desirable to add some written information to the video images from a high speed camera and the Olympus *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF provides this facility in the Permanent Text system.

The user may enter the first line of text. The second line of text will display a date/time stamp derived either from the cameras internal clock or for *i*-SPEED FS cameras optionally from an external IRIG timing signal. The third line displays the frame number prefixed by an F. The user may also add a small logo to the edge of the area. The logo must be supplied to the camera on a Compact Flash card and should be a bmp file with 32(h) to 150(h) pixels in 16.7 million colours (24 bit) and should be in a folder called logos\permtext\ on the card. The total area of the permanent text is 400 pixels x 32 pixels high.

The Permanent Text may be placed at the top or bottom of the image and aligned to the left or right.

This text and logo are destructively overlaid on the pixels of the image, so they will be zoomed by the zoom engine. If the sensor is run at reduced resolutions (due to economy modes or high speeds), the video and permanent text is automatically zoomed. If sensor resolution is very low it is possible that some permanent text may be clipped off.

Permanent text will be excluded from video recovered by the soft reset function.

i-SPEED TR cameras do not have these features.

Chapter 10 Maintenance

CAUTION

To prevent electric shock or damage to equipment, always disconnect from the power supply before attempting to clean.

10.1 Cleaning

Camera CMOS protective glass and CDU screen

Clean using lens tissues moistened with a solvent solution composed of 70% ether / 30% industrial methylated spirits.
DO NOT use hard or abrasive materials.

Camera cooling holes

Periodically inspect the camera cooling holes to ensure they are not blocked with fluff, dirt etc. Clean as necessary.

General cleaning

Wipe equipment clean with a soft cloth dampened with a mild detergent solution.

10.2 Storage and transportation

After use

Always pack the product in the kit case after use or for transportation.

10.3 Battery removal/replacement

WARNING

- The emergency backup battery is a customised Lithium Ion unit and should not be replaced with any other battery, even if it looks the same and is the same size. It is a high energy unit and must be treated with care.
- The emergency backup battery should only be charged in the camera or with a charger specifically recommended by Olympus.
- The emergency backup battery must never be:
  - short circuited
  - punctured, dismantled, physically shocked or deformed
  - heated above 60°C
  - cooled below -20°C
  - disposed of in fire
  - immersed in liquid

NOTE

When inserting a new battery, the tab should be placed in the slot provided, so that it does not obscure the power meter.

1. Undo the four captive screws and remove the battery cover, noting the cut out is positioned at the top.

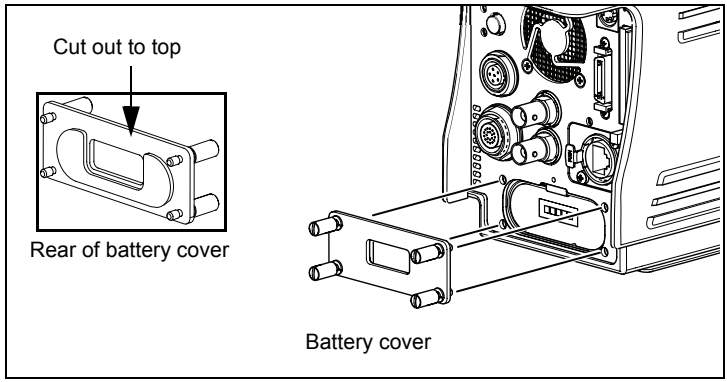


Figure 10.1

2. Draw out the battery tab using a suitable tool, then pull the tab to remove the battery.

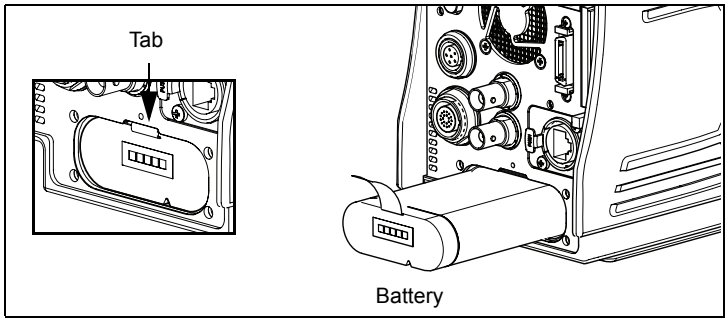


Figure 10.2

If the tab cannot be extracted, take a firm hold of the camera with both hands, and ensuring one hand is under the rear of the camera covering the battery, tilt the camera up and give a small sharp shake to dislodge the battery into the hand. Lay the camera flat and remove the battery.

CAUTION

Take extreme care not to drop the camera and/or battery.

3. On reassembly, slide the battery into the battery housing with the tab and battery contacts to the top. Tuck the tab into the slot and ensure the battery is pushed fully home (Figure 10.2 inset).

4. Replace the battery cover noting that the cut out should be to the top (Figure 10.1 inset). Tighten the four captive screws.

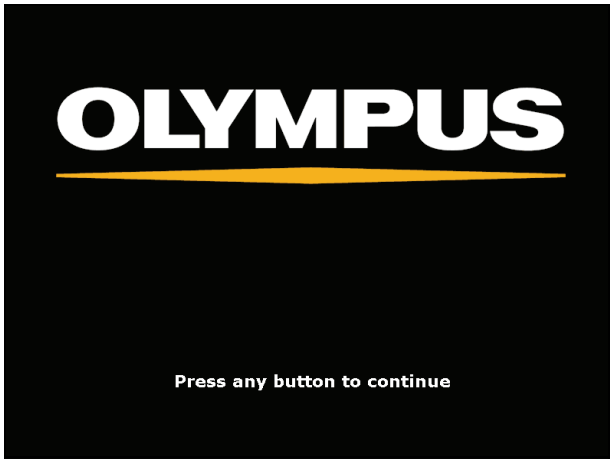
10.4 Soft reset

The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF high-speed video camera has been designed for use in industrial applications and has been tested to meet internationally recognised standards, but in the unlikely event that the camera stops responding it can be restarted using the soft rest facility. This will enable access to a data recovery menu; which allows any video stored on the cameras internal memory to be saved to a Compact Flash card.

To operate the soft reset, eject the Compact Flash card if inserted, push a pin through the access hole labelled RST in the rear panel of the camera.

After the normal start-up time, the camera will operate and the splash screen will appear.

The red flashing LED error warning will be displayed by *i*-CHEQ during this time. This is normal and should be ignored.



Press any button to access the data recovery menu.

The Player, Card (when Compact Flash is reinserted) and Power OFF options will be presented. The Player screen allows the user to clip select and save to Compact Flash card.

The data recovery menu gives access to the cameras entire memory independent of how long the camera was recording. This means that some of the memory may contain invalid data or previously recorded video.

10.5 Camera software and firmware upgrade

Periodically Olympus will issue new versions of camera software or firmware. Detailed instructions will be issued with each upgrade, but broadly the update procedure is as follows.

1. Navigate to Home ▸ Setup ▸ Config ▸ More.
2. Insert the Compact Flash card containing the upgrade.
3. Press the Camera update button.
4. Power down the camera when prompted.

10.6 Emergency shutdown

This camera contains sensitive electronic parts which could be damaged by operation at extreme temperatures. To prevent this, the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is equipped with internal temperature sensors. If the internal temperature approaches the safe working limit, the camera will display a warning box. If this is ignored, the camera will automatically shut down. The warning is displayed at 5 degrees Celsius before the limit is reached.

10.7 Repair

The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera contains a user replaceable battery (section 10.3) and fuse located in the rear panel. There are no other user repairable components.

Chapter 11 Spares and Accessories

Spares

	Part No.
Power Supply (19V DC) universal input	K10011378
Mains Cable - UK	K10011025
Mains Cable - Europe	K10011026
Mains Cable - USA	K10011027
Instructions (English)	K10007149
Camera fuse (pack of 5)	K10007986
Controller Cable, 3m	K7504982
PC software disk	K10007148
Ethernet crossover cable	K10008246
Feature Connector Cable	K10004999
FS Feature Connector Cable	K10015492
Trigger Switch	K7505051
CF to USB adapter	K10008251
Battery	K10007984
HG Battery	K10015295
Battery charger (UK)	K10009175
Battery charger (Europe)	K10009174

The following accessories are available for the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS and *i*-SPEED DF, contact Olympus for part numbers.

Accessories

Controller Display Unit with Controller Cable, 3m

Controller Cable, 3m

Controller Cable, 10m

Compact Flash Card

Memory upgrade

Lens kit

Lighting kit

In addition to the above items, a range of flash cards, tripods, lenses and lighting equipment is also available. Please contact Olympus for further information.

Software modules

Control module

Control Pro module

Data acquisition module

Software Development Kit (SDK)

Chapter 12 Specifications

12.1 i-SPEED TR, i-SPEED 3, i-SPEED FS, i-SPEED DF Camera

❍ Camera physical

Dimensions	
Size	W 112mm x H 141mm x L 341mm nominal
Weight	5kg nominal (including battery)

Mechanical connections	
Tripod mounting	3x standard tripod mounts (1/4" Whitworth thread) to 8mm depth located on base and both sides at approximate centre of gravity assuming a typical 28mm f1.4 lens is fitted. 1x 3/8" Whitworth thread mount on base.
Lens mounting	Nikon F-mount
High-G lens mounting	4x ¼" Whitworth thread fixing holes on the front of the camera for high-G lens attachment. Also suitable for mounting fixtures customised for specific lenses.
Accessory mounting	5x ¼" Whitworth thread fixing holes in the base and a further 5 holes in each side in the same pattern.
Back focus	Nominal position 17mm. F-mount can be screwed in 1mm and out 3mm. Rotary control locks the F-mount in position.
Laser alignment surface	The base and both sides of the camera provide a flat surface to facilitate laser alignment of the optical axis of the camera.

❍ Electrical

Power	
Input voltage	14V-0% to 28VDC +5%
Power consumption	Camera:70W max System:100W max

Fuse	
Type	20 x 5mm cartridge (coin slot screw access)
Rating	T8AH 250V

Battery	
Type	Lithium ion
Voltage	10.8V
Capacity	7.2Ah
Operation time	45 minutes minimum from full charge.
Charger	Automatic, built into camera.
Charging time	Approximately 3 hours depending on camera activity.
Charging current	4A maximum, depending on camera activity
Temperature range	The battery should only be charged between 0°C and 45°C battery temperature and discharged between -10°C and 50°C battery temperature.
Battery life	Usage dependent

Battery operation and switching	
Power button	Momentary switch. Press the power button to switch the camera ON. Press and hold for 4 seconds to switch the camera OFF. A “fault indication” will be given by the status group during this period. A pop-up box will also be displayed on the CDU.
Transitions	Standby to ON (main power): Power button OFF to ON (battery power): Power button ON to Charge only (main power): Menu or power button ON to OFF (battery power): Menu or power button ON (main power) to ON (battery power): Power failure
Switchover time	Switchover from main power to battery power is instantaneous with no loss of functionality.
No Battery	Camera will still operate correctly from main power if the battery is not fitted.
Low battery warning	10%
Auto power down	5%

External LEDs	
Power	ON DC Illuminates green when camera is powered from external DC source. ON BATT Illuminates red when camera is powered from battery. CHARGE Flashes orange when battery is being charged, steady orange when battery is charged.
Ethernet	Connection speed is indicated by solid colour: 10Mb connection - Red LED 100Mb connection - Green LED 1Gb connection - Orange LED Flashing LED indicates Ethernet activity

Camera status group *i*-CHEQ

Three RGB multicolour LEDs located in the handle indicate the current status of the camera as follows:

Camera operation	**Mode**	**Status**	**Pattern**
Start-up		Camera software booting	Blue, sweeping left to right
Record	Normal	No trigger received	Green, sweeping left to right
Record	Normal	Trigger received, timeout in progress	Green, alternating left & right
Record	ROC BROC	Waiting for trigger to start burst	Green, sweeping left to right
Record	ROC BROC	Burst recording in progress	Green, alternating left & right
Record	Stopped	Done (end of memory or trigger timeout complete)	All LEDS fixed Green
Error	Error	An internal error has been detected	All LEDs rapidly flashing red simultaneously.

All	Power button	Power button pressed	All LEDs rapidly alternating red / blue simultaneously. After 1 second, right LED extinguishes, after another 1 second centre extinguishes, after another 1 second left fades for 1 second. 4 seconds in total.

❍ Connectors

Power input				
Type	Lemo series 2B 6 way. EEG 2B 306 CLN			
Pinout	1	Power in	4	Power ground
	2	Power ground	5	Power in
	3	Power ground	6	Power in
	Screen: Case ground			

Ethernet				
Type	Neutrik ruggedised RJ45 Type NE8FBH			
Pinout	1	GB1+	5	GB3-
	2	GB1-	6	GB2-
	3	GB2+	7	GB4+
	4	GB3+	8	GB4-
	Screen: Case ground			
Ethernet signal	10 / 100 / 1000 Base-T, auto switching			
Status LED	Connection speed is indicated by colour: 10MB connection - Red LED 100MB connection - Green LED 1GB connection - Orange LED			
	Ethernet activity is indicated by flashing of the LED in the appropriate colour (see above)			

Compact Flash	
Standard	Type I and II
Vpp Level	0V, 3V3, auto select
Vcc Level	3V3
Connection	Hot swappable

Controller Connector				
Type	Standard LVDS connector, 26 way MDR			
Pinout	1	Ground	14	Tx0-
	2	Tx0 shield	15	Tx0+
	3	5V output	16	ground
	4	Tx1-	17	Tx1 shield
	5	Tx1+	18	5V output
	6	RS-232 Tx	19	RS-232 Ground
	7	RS-232 Rx	20	Tx2-
	8	Tx2 shield	21	Tx2+
	9	12V output	22	TxC-
	10	TxC shield	23	TxC+
	11	12V output	24	12V output
	12	Tx3-	25	Tx3 shield
	13	Tx3+	26	Ground
	Screen: Case ground			
Power outputs	5V @ 2W max			
RS-232	RS-232 link for the CDU			
LVDS	Digital signals for 3x 8 bit interface to CDU			

Feature connector				
Type	Lemo series 3B 18 way. EEG 3B 318 CLN			
Pinout	1	RS-232 Tx (data out of HSVC)	10	Trigger output
	2	+12V out	11	Remote Power
	3	Trigger input/IRIG input (*i*-SPEED FS)	12	RS-232 Tx (data into HSVC)
	4	Sync input	13	RS-232 & Remote Power & 12V ground
	5	Exposure output	14	Trig in ground/IRIG in ground (*i*-SPEED FS)
	6	Ready output	15	Sync in ground
	7	Ready and Fault ground	16	Exposure out ground
	8	Fault out	17	Sync out ground

	9	Sync output	18	Trig out ground
	Screen: Case ground			
Sync in	Level: 5V TTL, +12V tolerant Impedance: 10k ohms to ground ±10%			
Sync out	Level: 5V nominal TTL Impedance: 50 ohms ±10%, short circuit tolerant			
Trigger in	Level: 3.3V or 5V TTL, +24V tolerant Impedance: 10k ohms (pulled to +5V for trigger switch) Bandwidth: 100kHz			
Trigger out	Level: 5V nominal TTL Impedance: 50 ohms ±10%, short circuit tolerant			
Diagnostic Serial port	RS-232			
Exposure out	Level: 5V nominal TTL Impedance: 50 ohms ±10%, short circuit tolerant			
Ready out	Level: 5V nominal TTL Impedance: 50 ohms ±10%, short circuit tolerant			
Fault out	Level: 5V nominal TTL Impedance: 50 ohms ±10%, short circuit tolerant			
Remote power	Level: Active low (<1V), inactive must be open circuit (>1M ohm) Impedance: 33k ohm pull-up to DC power-in. Function: Connection to ground mimics the function of pressing the power switch.			
Power output	12V @ 3W max			

Composite video out	
Type	BNC
Colour code	Yellow
Standard	NTSC / PAL switchable
Level	1Vp-p
Impedance	75 ohms, short circuit tolerant

Trigger input	
Type	BNC
Colour code	Blue
Level	3.3V or 5V TTL, +24V tolerant
Impedance	10k ohms (pulled to +5V for trigger switch)
Bandwidth	100kHz
Internal connection	Electrically connected to pin 3 of feature connector

S-video connector				
Type	4 pin mini-DIN			
Pinout	1	Ground	2	Ground
	3	Y signal	4	C signal
	Screen: Case ground			
Standard	NTSC / PAL switchable			
Level	1Vp-p			
Impedance	75 ohms, short circuit tolerant			

❍ Performance characteristics

Resolutions, speeds & record times	
Sensor	CMOS
Resolution	1280 x 1024 active pixels
Frame rate	Maximum: *i*-SPEED TR 10,000 fps *i*-SPEED 3 150,000 fps *i*-SPEED FS 1,000,000 fps *i*-SPEED DF 300,000 fps Minimum: 1 fps Maximum for full resolution: 2,000 fps
Economy modes	3 each of Tall, Wide, Square, Manual
Nominal values of speeds and resolutions	See following tables

Nominal values of speeds and resolutions *i*-SPEED TR: Min shutter 2.169µs										
Speed (fps)	Resolution (pixels)	Memory size						Max Shutter		Min Shutter (x)
		4GB		8GB		16GB				
		Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Absolute (ms/µs)	Relative (x)	
1	1280 x 1024	2447.000	2,447	4897.000	4,897	9797.000	9,797	999.996	1	461,041
2	1280 x 1024	1223.500	2,447	2448.500	4,897	4898.500	9,797	499.996	1	230,520
3	1280 x 1024	815.667	2,447	1632.330	4,897	3265.670	9,797	333.329	1	153,680
4	1280 x 1024	611.750	2,447	1224.250	4,897	2449.250	9,797	249.996	1	115,260
5	1280 x 1024	489.400	2,447	979.400	4,897	1959.400	9,797	199.996	1	92,208
7	1280 x 1024	349.571	2,447	699.571	4,897	1399.570	9,797	142.853	1	65,863
10	1280 x 1024	244.700	2,447	489.700	4,897	979.700	9,797	99.9959	1	46,104
15	1280 x 1024	163.133	2,447	326.467	4,897	653.133	9,797	66.6626	1	30,736
20	1280 x 1024	122.350	2,447	244.850	4,897	489.850	9,797	49.9959	1	23,052
25	1280 x 1024	97.880	2,447	195.880	4,897	391.880	9,797	39.9959	1	18,441
30	1280 x 1024	81.567	2,447	163.233	4,897	326.567	9,797	33.3293	1	15,368
40	1280 x 1024	61.175	2,447	122.425	4,897	244.925	9,797	24.9959	1	11,526
50	1280 x 1024	48.940	2,447	97.940	4,897	195.940	9,797	19.9959	1	9,220
60	1280 x 1024	40.783	2,447	81.617	4,897	163.283	9,797	16.6626	1	7,684
75	1280 x 1024	32.627	2,447	65.293	4,897	130.627	9,797	13.3293	1	6,147
100	1280 x 1024	24.470	2,447	48.970	4,897	97.970	9,797	9.99594	1	4,610
150	1280 x 1024	16.313	2,447	32.647	4,897	65.313	9,797	6.6626	1	3,073
200	1280 x 1024	12.235	2,447	24.485	4,897	48.985	9,797	4.99594	1	2,305
300	1280 x 1024	8.157	2,447	16.323	4,897	32.657	9,797	3.32926	1	1,536
400	1280 x 1024	6.118	2,447	12.243	4,897	24.493	9,797	2.49594	1	1,152
500	1280 x 1024	4.894	2,447	9.794	4,897	19.594	9,797	1.99594	1	922
750	1280 x 1024	3.263	2,447	6.529	4,897	13.063	9,797	1.32926	1	614
1,000	1280 x 1024	2.447	2,447	4.897	4,897	9.797	9,797	995.938	1	461
1,500	1280 x 1024	1.631	2,447	3.265	4,897	6.531	9,797	662.6	1	307
2,000	1280 x 1024	1.224	2,447	2.449	4,897	4.899	9,797	495.938	1	230
3,000	1068 x 800	1.256	3,767	2.512	7,537	5.026	15,077	329.261	1	153
4,000	912 x 684	1.290	5,159	2.581	10,323	5.163	20,651	245.938	1	115
5,000	804 x 600	1.334	6,672	2.670	13,349	5.341	26,704	195.938	1	92
7,500	636 x 476	1.417	10,631	2.836	21,272	5.674	42,552	129.261	1	61
10,000	528 x 396	1.539	15,393	3.080	30,799	6.161	61,611	95.938	1	46

Nominal values of speeds and resolutions *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF in HQ Optimize Mode, Auto sync mode: Min shutter 2.169µs										
Speed (fps)	Resolution (pixels)	Memory size						Max Shutter		Min Shutter (x)
		4GB		8GB		16GB				
		Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Absolute (ms/µs)	Relative (x)	
1	1280 x 1024	2447.000	2,447	4897.000	4,897	9797.000	9,797	999.996	1	461,041
2	1280 x 1024	1223.500	2,447	2448.500	4,897	4898.500	9,797	499.996	1	230,520
3	1280 x 1024	815.667	2,447	1632.330	4,897	3265.670	9,797	333.329	1	153,680
4	1280 x 1024	611.750	2,447	1224.250	4,897	2449.250	9,797	249.996	1	115,260
5	1280 x 1024	489.400	2,447	979.400	4,897	1959.400	9,797	199.996	1	92,208
7	1280 x 1024	349.571	2,447	699.571	4,897	1399.570	9,797	142.853	1	65,863
10	1280 x 1024	244.700	2,447	489.700	4,897	979.700	9,797	99.9959	1	46,104
15	1280 x 1024	163.133	2,447	326.467	4,897	653.133	9,797	66.6626	1	30,736
20	1280 x 1024	122.350	2,447	244.850	4,897	489.850	9,797	49.9959	1	23,052
25	1280 x 1024	97.880	2,447	195.880	4,897	391.880	9,797	39.9959	1	18,441
30	1280 x 1024	81.567	2,447	163.233	4,897	326.567	9,797	33.3293	1	15,368
40	1280 x 1024	61.175	2,447	122.425	4,897	244.925	9,797	24.9959	1	11,526
50	1280 x 1024	48.940	2,447	97.940	4,897	195.940	9,797	19.9959	1	9,220
60	1280 x 1024	40.783	2,447	81.617	4,897	163.283	9,797	16.6626	1	7,684
75	1280 x 1024	32.627	2,447	65.293	4,897	130.627	9,797	13.3293	1	6,147
100	1280 x 1024	24.470	2,447	48.970	4,897	97.970	9,797	9.99594	1	4,610
150	1280 x 1024	16.313	2,447	32.647	4,897	65.313	9,797	6.6626	1	3,073
200	1280 x 1024	12.235	2,447	24.485	4,897	48.985	9,797	4.99594	1	2,305
300	1280 x 1024	8.157	2,447	16.323	4,897	32.657	9,797	3.32926	1	1,536
400	1280 x 1024	6.118	2,447	12.243	4,897	24.493	9,797	2.49594	1	1,152
500	1280 x 1024	4.894	2,447	9.794	4,897	19.594	9,797	1.99594	1	922
750	1280 x 1024	3.263	2,447	6.529	4,897	13.063	9,797	1.32926	1	614
1,000	1280 x 1024	2.447	2,447	4.897	4,897	9.797	9,797	995.938	1	461
1,500	1280 x 1024	1.631	2,447	3.265	4,897	6.531	9,797	662.6	1	307
2,000	1280 x 1024	1.224	2,447	2.449	4,897	4.899	9,797	495.938	1	230
3,000	1068 x 800	1.256	3,767	2.512	7,537	5.026	15,077	329.261	1	153
4,000	912 x 684	1.290	5,159	2.581	10,323	5.163	20,651	245.938	1	115
5,000	804 x 600	1.334	6,672	2.670	13,349	5.341	26,704	195.938	1	92
7,500	636 x 476	1.417	10,631	2.836	21,272	5.674	42,552	129.261	1	61
10,000	528 x 396	1.539	15,393	3.080	30,799	6.161	61,611	95.938	1	46
15,000	420 x 312	1.637	24,561	3.276	49,143	6.554	98,307	62.6	1	30
20,000	348 x 260	1.779	35,572	3.559	71,173	7.119	142,377	45.938	1	23
30,000	264 x 196	2.073	62,202	4.148	124,455	8.299	248,961	29.261	1	15
40,000	216 x 160	2.328	93,130	4.658	186,337	9.319	372,750	20.938	1	11
50,000	180 x 132	2.709	135,462	5.421	271,036	10.844	542,183	15.938	1	9
75,000	132 x 96	3.386	253,992	6.776	508,192	13.554	1,016,593	9.261	1	6
100,000	96 x 72	4.657	465,653	9.317	931,687	18.638	1,863,754	5.938	1	4
150,000	60 x 44	8.127	1,219,165	16.261	2,439,326	32.528	4,879,648	2.6	2	3

Nominal values of speeds and resolutions *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF in QS Optimize Mode, Auto sync mode: Min shutter 1µs										
Speed (fps)	Resolution (pixels)	Memory size						Max Shutter		Min Shutter (x)
		4GB		8GB		16GB				
		Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Absolute (ms/µs)	Relative (x)	
1	1280 x 1024	2447.000	2,447	4897.000	4,897	9797.000	9,797	999.998	1	1000000
2	1280 x 1024	1223.500	2,447	2448.500	4,897	4898.500	9,797	499.998	1	500000
3	1280 x 1024	815.667	2,447	1632.330	4,897	3265.670	9,797	333.331	1	333333
4	1280 x 1024	611.750	2,447	1224.250	4,897	2449.250	9,797	249.998	1	250000
5	1280 x 1024	489.400	2,447	979.400	4,897	1959.400	9,797	199.998	1	200000
7	1280 x 1024	349.571	2,447	699.571	4,897	1399.570	9,797	142.855	1	142857
10	1280 x 1024	244.700	2,447	489.700	4,897	979.700	9,797	99.9981	1	100000
15	1280 x 1024	163.133	2,447	326.467	4,897	653.133	9,797	66.6648	1	66666
20	1280 x 1024	122.350	2,447	244.850	4,897	489.850	9,797	49.9981	1	50000
25	1280 x 1024	97.880	2,447	195.880	4,897	391.880	9,797	39.9981	1	40000
30	1280 x 1024	81.567	2,447	163.233	4,897	326.567	9,797	33.3314	1	33333
40	1280 x 1024	61.175	2,447	122.425	4,897	244.925	9,797	24.9981	1	25000
50	1280 x 1024	48.940	2,447	97.940	4,897	195.940	9,797	19.9981	1	20000
60	1280 x 1024	40.783	2,447	81.617	4,897	163.283	9,797	16.6648	1	16666
75	1280 x 1024	32.627	2,447	65.293	4,897	130.627	9,797	13.3314	1	13333
100	1280 x 1024	24.470	2,447	48.970	4,897	97.970	9,797	9.99811	1	10000
150	1280 x 1024	16.313	2,447	32.647	4,897	65.313	9,797	6.66477	1	6666
200	1280 x 1024	12.235	2,447	24.485	4,897	48.985	9,797	4.99811	1	5000
300	1280 x 1024	8.157	2,447	16.323	4,897	32.657	9,797	3.33143	1	3333
400	1280 x 1024	6.118	2,447	12.243	4,897	24.493	9,797	2.49811	1	2500
500	1280 x 1024	4.894	2,447	9.794	4,897	19.594	9,797	1.99811	1	2000
750	1280 x 1024	3.263	2,447	6.529	4,897	13.063	9,797	1.33143	1	1333
1,000	1280 x 1024	2.447	2,447	4.897	4,897	9.797	9,797	998.107	1	1000
1,500	1280 x 1024	1.631	2,447	3.265	4,897	6.531	9,797	664.769	1	666
2,000	1280 x 1024	1.224	2,447	2.449	4,897	4.899	9,797	498.107	1	500
3,000	1068 x 800	1.256	3,767	2.512	7,537	5.026	15,077	331.43	1	333
4,000	912 x 684	1.290	5,159	2.581	10,323	5.163	20,651	248.107	1	250
5,000	804 x 600	1.334	6,672	2.670	13,349	5.341	26,704	198.107	1	200
7,500	636 x 476	1.417	10,631	2.836	21,272	5.674	42,552	131.43	1	133
10,000	540 x 404	1.475	14,753	2.952	29,518	5.905	59,049	98.107	1	100
15,000	420 x 312	1.637	24,561	3.276	49,143	6.554	98,307	64.769	1	66
20,000	348 x 260	1.779	35,572	3.559	71,173	7.119	142,377	48.107	1	50
30,000	264 x 196	2.073	62,202	4.148	124,455	8.299	248,961	31.43	1	33
40,000	216 x 160	2.328	93,130	4.658	186,337	9.319	372,750	23.107	1	25
50,000	180 x 132	2.709	135,462	5.421	271,036	10.844	542,183	18.107	1	20
75,000	132 x 96	3.386	253,992	6.776	508,192	13.554	1,016,593	11.43	1	13
100,000	108 x 80	3.725	372,522	7.453	745,349	14.910	1,491,003	8.107	1	10
150,000	72 x 52	5.731	859,667	11.466	1,720,037	22.936	3,440,777	4.769	1	6

Nominal values of speeds and resolutions
***i*-SPEED FS in FS Optimize Mode, Auto sync mode: Min shutter 200ns**

Speed (fps)	Resolution (pixels)	Memory size						Max Shutter		Min Shutter (x)
		4GB		8GB		16GB				
		Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Absolute (ms/µs)	Relative (x)	
1	1280 x 1024	2447.000	2,447	4897.000	4,897	9797.000	9,797	999.999	1	5000000
2	1280 x 1024	1223.500	2,447	2448.500	4,897	4898.500	9,797	499.999	1	2500000
3	1280 x 1024	815.667	2,447	1632.330	4,897	3265.670	9,797	333.333	1	1666666
4	1280 x 1024	611.750	2,447	1224.250	4,897	2449.250	9,797	249.999	1	1250000
5	1280 x 1024	489.400	2,447	979.400	4,897	1959.400	9,797	199.999	1	1000000
7	1280 x 1024	349.571	2,447	699.571	4,897	1399.570	9,797	142.856	1	714285
10	1280 x 1024	244.700	2,447	489.700	4,897	979.700	9,797	99.9993	1	500000
15	1280 x 1024	163.133	2,447	326.467	4,897	653.133	9,797	66.666	1	333333
20	1280 x 1024	122.350	2,447	244.850	4,897	489.850	9,797	49.9993	1	250000
25	1280 x 1024	97.880	2,447	195.880	4,897	391.880	9,797	39.9993	1	200000
30	1280 x 1024	81.567	2,447	163.233	4,897	326.567	9,797	33.3327	1	166666
40	1280 x 1024	61.175	2,447	122.425	4,897	244.925	9,797	24.9993	1	125000
50	1280 x 1024	48.940	2,447	97.940	4,897	195.940	9,797	19.9993	1	100000
60	1280 x 1024	40.783	2,447	81.617	4,897	163.283	9,797	16.666	1	83333
75	1280 x 1024	32.627	2,447	65.293	4,897	130.627	9,797	13.3327	1	66666
100	1280 x 1024	24.470	2,447	48.970	4,897	97.970	9,797	9.99934	1	50000
150	1280 x 1024	16.313	2,447	32.647	4,897	65.313	9,797	6.666	1	33333
200	1280 x 1024	12.235	2,447	24.485	4,897	48.985	9,797	4.99934	1	25000
300	1280 x 1024	8.157	2,447	16.323	4,897	32.657	9,797	3.33266	1	16666
400	1280 x 1024	6.118	2,447	12.243	4,897	24.493	9,797	2.49934	1	12500
500	1280 x 1024	4.894	2,447	9.794	4,897	19.594	9,797	1.99934	1	10000
750	1280 x 1024	3.263	2,447	6.529	4,897	13.063	9,797	1.33266	1	6666
1,000	1280 x 1024	2.447	2,447	4.897	4,897	9.797	9,797	999.338	1	5000
1,500	1280 x 1024	1.631	2,447	3.265	4,897	6.531	9,797	666	1	3333
2,000	1280 x 1024	1.224	2,447	2.449	4,897	4.899	9,797	499.338	1	2500
3,000	1104 x 828	1.174	3,521	2.348	7,044	4.697	14,092	332.661	1	1666
4,000	948 x 708	1.199	4,795	2.399	9,594	4.798	19,193	249.338	1	1250
5,000	840 x 628	1.220	6,101	2.441	12,207	4.884	24,420	199.338	1	1000
7,500	672 x 504	1.267	9,503	2.535	19,014	5.071	38,035	132.661	1	666
10,000	564 x 420	1.359	13,587	2.719	27,186	5.438	54,383	99.338	1	500
15,000	456 x 340	1.384	20,759	2.769	41,536	5.539	83,089	66	1	333
20,000	384 x 288	1.455	29,103	2.912	58,230	5.824	116,484	49.338	1	250
30,000	300 x 224	1.596	47,895	3.194	95,830	6.390	191,700	32.661	1	166
40,000	252 x 188	1.698	67,937	3.398	135,930	6.798	271,915	24.338	1	125
50,000	216 x 160	1.863	93,130	3.727	186,337	7.455	372,750	19.338	1	100
75,000	168 x 124	2.060	154,502	4.122	309,131	8.245	618,388	12.661	1	66
100,000	132 x 96	2.540	253,992	5.082	508,192	10.166	1,016,593	9.338	1	50
150,000	96 x 72	3.104	465,653	6.211	931,687	12.424	1,863,754	6	1	33
200,000	84 x 60	3.193	638,610	6.389	1,277,742	12.780	2,556,006	4.338	1	25
300,000	48 x 36	6.208	1,862,613	12.421	3,726,748	24.848	7,455,018	2.661	1	16
400,000	36 x 24	9.313	3,725,226	18.634	7,453,496	37.275	14,910,037	1.83	1	12
500,000	36 x 24	7.450	3,725,226	14.907	7,453,496	29.820	14,910,037	1.338	1	10
750,000	24 x 8	22.346	16,763,520	44.710	33,540,736	89.438	67,095,168	0.661	2	6
1,000,000	24 x 8	16.764	16,763,520	33.541	33,540,736	67.095	67,095,168	0.338	2	5

Nominal values of speeds and resolutions
***i*-SPEED DF in SIF Optimize Mode, Auto sync mode: Min shutter 1µs**

Speed (fps)	Resolution (pixels)	Memory size						Max Shutter		Min Shutter (x)
		4GB		8GB		16GB				
		Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Record Time (s)	Frames in Memory	Absolute (ms/µs)	Relative (x)	
1	1280 x 1024	2447.000	2,447	4897.000	4,897	9797.000	9,797	999.999	1	1000000
2	1280 x 1024	1223.500	2,447	2448.500	4,897	4898.500	9,797	499.999	1	500000
3	1280 x 1024	815.667	2,447	1632.330	4,897	3265.670	9,797	333.333	1	333333
4	1280 x 1024	611.750	2,447	1224.250	4,897	2449.250	9,797	249.999	1	250000
5	1280 x 1024	489.400	2,447	979.400	4,897	1959.400	9,797	199.999	1	200000
7	1280 x 1024	349.571	2,447	699.571	4,897	1399.570	9,797	142.857	1	142857
10	1280 x 1024	244.700	2,447	489.700	4,897	979.700	9,797	99.9994	1	100000
15	1280 x 1024	163.133	2,447	326.467	4,897	653.133	9,797	66.666	1	66666
20	1280 x 1024	122.350	2,447	244.850	4,897	489.850	9,797	49.9994	1	50000
25	1280 x 1024	97.880	2,447	195.880	4,897	391.880	9,797	39.9994	1	40000
30	1280 x 1024	81.567	2,447	163.233	4,897	326.567	9,797	33.3327	1	33333
40	1280 x 1024	61.175	2,447	122.425	4,897	244.925	9,797	24.9994	1	25000
50	1280 x 1024	48.940	2,447	97.940	4,897	195.940	9,797	19.9994	1	20000
60	1280 x 1024	40.783	2,447	81.617	4,897	163.283	9,797	16.666	1	16666
75	1280 x 1024	32.627	2,447	65.293	4,897	130.627	9,797	13.3327	1	13333
100	1280 x 1024	24.470	2,447	48.970	4,897	97.970	9,797	9.99937	1	10000
150	1280 x 1024	16.313	2,447	32.647	4,897	65.313	9,797	6.66603	1	6666
200	1280 x 1024	12.235	2,447	24.485	4,897	48.985	9,797	4.99937	1	5000
300	1280 x 1024	8.157	2,447	16.323	4,897	32.657	9,797	3.33269	1	3333
400	1280 x 1024	6.118	2,447	12.243	4,897	24.493	9,797	2.49937	1	2500
500	1280 x 1024	4.894	2,447	9.794	4,897	19.594	9,797	1.99937	1	2000
750	1280 x 1024	3.263	2,447	6.529	4,897	13.063	9,797	1.33269	1	1333
1,000	1280 x 1024	2.447	2,447	4.897	4,897	9.797	9,797	999.369	1	1000
1,500	1280 x 1024	1.631	2,447	3.265	4,897	6.531	9,797	666.03	1	666
2,000	1280 x 1024	1.224	2,447	2.449	4,897	4.899	9,797	499.369	1	500
3,000	1104 x 828	1.174	3,521	2.348	7,044	4.697	14,092	332.692	1	333
4,000	948 x 708	1.199	4,795	2.399	9,594	4.798	19,193	249.369	1	250
5,000	840 x 628	1.220	6,101	2.441	12,207	4.884	24,420	199.369	1	200
7,500	672 x 504	1.267	9,503	2.535	19,014	5.071	38,035	132.692	1	133
10,000	564 x 420	1.359	13,587	2.719	27,186	5.438	54,383	99.369	1	100
15,000	456 x 340	1.384	20,759	2.769	41,536	5.539	83,089	66.03	1	66
20,000	384 x 288	1.455	29,103	2.912	58,230	5.824	116,484	49.369	1	50
30,000	300 x 224	1.596	47,895	3.194	95,830	6.390	191,700	32.692	1	33
40,000	252 x 188	1.698	67,937	3.398	135,930	6.798	271,915	24.369	1	25
50,000	216 x 160	1.863	93,130	3.727	186,337	7.455	372,750	19.369	1	20
75,000	168 x 124	2.060	154,502	4.122	309,131	8.245	618,388	12.692	1	13
100,000	132 x 96	2.540	253,992	5.082	508,192	10.166	1,016,593	9.369	1	10
150,000	96 x 72	3.104	465,653	6.211	931,687	12.424	1,863,754	6.03	1	6
200,000	84 x 60	3.193	638,610	6.389	1,277,742	12.780	2,556,006	4.369	1	5
300,000	48 x 36	6.208	1,862,613	12.421	3,726,748	24.848	7,455,018	2.692	1	3

Nominal values of speeds and resolutions *i*-SPEED DF in HQ Optimize Mode, DF sync mode Min shutter 2.169µs, Min Inter Frame Delay 4.076µs						
Resolution (pixels)	Max Double Frame Speed (dfps)	Memory size			Min Double Frame Delay (µs)	Max Shutter
		4GB	8GB	16GB		
		Frames in Memory	Frames in Memory	Frames in Memory		Absolute (µs)
1280 x 1024	1,010	2447	4897	9797	494.707	490.63
1280 x 960	1,077	2611	5224	10450	463.938	459.861
1272 x 952	1,095	2657	5318	10638	456.43	452.353
1260 x 944	1,113	2705	5414	10830	448.984	444.907
1248 x 936	1,132	2755	5512	11028	441.6	437.523
1236 x 924	1,156	2818	5638	11279	432.415	428.338
1224 x 916	1,175	2870	5743	11489	425.169	421.092
1212 x 908	1,196	2924	5851	11705	417.984	413.907
1200 x 900	1,216	2980	5962	11928	410.861	406.784
1188 x 888	1,243	3050	6104	12211	402	397.923
1176 x 880	1,265	3110	6222	12448	395.015	390.938
1164 x 872	1,288	3171	6344	12691	388.092	384.015
1152 x 864	1,311	3233	6470	12942	381.23	377.153
1140 x 852	1,341	3313	6630	13263	372.692	368.615
1128 x 844	1,366	3380	6764	13531	365.969	361.892
1116 x 836	1,391	3449	6902	13807	359.307	355.23
1104 x 828	1,417	3521	7044	14092	352.707	348.63
1092 x 816	1,451	3612	7227	14457	344.492	340.415
1080 x 808	1,479	3688	7379	14762	338.03	333.953
1068 x 800	1,507	3767	7537	15077	331.63	327.553
1056 x 792	1,537	3848	7699	15402	325.292	321.215
1044 x 780	1,575	3952	7908	15819	317.4	313.323
1032 x 772	1,606	4039	8083	16169	311.2	307.123
1020 x 764	1,638	4130	8263	16530	305.061	300.984
1008 x 756	1,672	4223	8450	16904	298.984	294.907
996 x 744	1,715	4343	8690	17384	291.415	287.338
984 x 736	1,751	4444	8892	17787	285.476	281.4
972 x 728	1,788	4548	9100	18205	279.6	275.523
960 x 720	1,826	4656	9316	18637	273.784	269.707
948 x 708	1,875	4795	9594	19193	266.538	262.461
936 x 700	1,916	4912	9828	19661	260.861	256.784
924 x 692	1,958	5033	10071	20147	255.246	251.169
912 x 684	2,002	5159	10323	20651	249.692	245.615
900 x 672	2,059	5321	10647	21300	242.769	238.692
888 x 664	2,106	5458	10921	21847	237.353	233.276
876 x 656	2,155	5600	11206	22417	232	227.923
864 x 648	2,205	5748	11502	23009	226.707	222.63
852 x 636	2,271	5939	11884	23773	220.107	216.03
840 x 628	2,325	6101	12207	24420	214.953	210.876
828 x 620	2,382	6269	12544	25094	209.861	205.784
816 x 612	2,440	6445	12895	25795	204.83	200.753
804 x 600	2,518	6672	13349	26704	198.553	194.476
792 x 592	2,581	6864	13734	27475	193.661	189.584
780 x 584	2,647	7065	14137	28280	188.83	184.753
768 x 576	2,716	7275	14557	29121	184.061	179.984
756 x 564	2,807	7548	15103	30212	178.107	174.03
744 x 556	2,882	7780	15567	31141	173.476	169.4
732 x 548	2,960	8023	16053	32114	168.907	164.83
720 x 540	3,041	8278	16563	33133	164.4	160.323
708 x 528	3,149	8609	17226	34460	158.769	154.692
696 x 520	3,238	8893	17793	35594	154.4	150.323
684 x 512	3,331	9190	18388	36784	150.092	146.015
672 x 504	3,428	9503	19014	38035	145.846	141.769
660 x 492	3,557	9911	19831	39671	140.538	136.461
648 x 484	3,664	10262	20533	41074	136.43	132.353
636 x 476	3,776	10631	21272	42552	132.384	128.307
624 x 468	3,893	11021	22051	44112	128.4	124.323
612 x 456	4,051	11533	23075	46161	123.415	119.338
600 x 448	4,181	11973	23957	47925	119.569	115.492
588 x 440	4,318	12440	24891	49792	115.784	111.707
576 x 432	4,461	12934	25880	51770	112.061	107.984

552 x 412	4,815	14152	28316	56644	103.815	99.738
540 x 404	4,985	14753	29518	59049	100.292	96.215
528 x 396	5,163	15393	30799	61611	96.83	92.753
516 x 384	5,405	16243	32500	65014	92.492	88.415
504 x 376	5,606	16984	33982	67978	89.169	85.092
492 x 368	5,819	17776	35568	71150	85.907	81.83
480 x 360	6,044	18626	37267	74550	82.707	78.63
468 x 348	6,353	19762	39541	79098	78.692	74.615
456 x 340	6,610	20759	41536	83089	75.63	71.553
444 x 332	6,883	21834	43687	87391	72.63	68.553
432 x 324	7,173	22995	46009	92037	69.692	65.615
420 x 312	7,574	24561	49143	98307	66	61.923
408 x 304	7,910	25949	51920	103862	63.2	59.123
396 x 296	8,268	27458	54939	109901	60.461	56.384
384 x 288	8,651	29103	58230	116484	57.784	53.707
372 x 276	9,187	31348	62722	125470	54.415	50.338
360 x 268	9,636	33360	66747	133522	51.876	47.8
348 x 260	10,119	35572	71173	142377	49.4	45.323
336 x 252	10,640	38012	76056	152143	46.984	42.907
324 x 240	11,377	41391	82816	165667	43.938	39.861
312 x 232	11,999	44465	88967	177971	41.661	37.584
300 x 224	12,673	47895	95830	191700	39.446	35.369
288 x 216	13,404	51739	103520	207083	37.292	33.215
276 x 204	14,460	57164	114375	228798	34.569	30.492
264 x 196	15,355	62202	124455	248961	32.553	28.476
252 x 188	16,335	67937	135930	271915	30.6	26.523
240 x 180	17,412	74504	149069	298200	28.707	24.63
228 x 168	19,000	84027	168123	336316	26.307	22.23
216 x 160	20,357	93130	186337	372750	24.553	20.476
204 x 152	21,863	103798	207682	415449	22.861	18.784
192 x 144	23,542	116413	232921	465938	21.23	17.153
180 x 132	26,093	135462	271036	542183	19.153	15.076
168 x 124	28,297	154502	309131	618388	17.661	13.584
156 x 116	30,791	177862	355869	711885	16.23	12.153
144 x 108	33,626	206957	414083	828335	14.861	10.784
132 x 96	38,123	253992	508192	1016593	13.107	9.03
120 x 88	42,071	304791	609831	1219912	11.876	7.8
108 x 80	46,661	372522	745349	1491003	10.707	6.63
96 x 72	52,041	465653	931687	1863754	9.6	5.523
84 x 60	61,147	638610	1277742	2556006	8.169	4.092
72 x 52	69,370	859667	1720037	3440777	7.2	3.123
60 x 44	74,971	1219165	2439326	4879648	6.661	2.584
48 x 36	74,971	1862613	3726748	7455018	6.661	2.584
36 x 24	74,971	3725226	7453496	14910037	6.661	2.584
24 x 16	74,971	8381760	16770368	33547584	6.661	2.584
24 x 8	74,971	16763520	33540736	67095168	6.661	2.584

Nominal values of speeds and resolutions
***i*-SPEED DF in QS Optimize Mode, DF sync mode**
Min shutter 1µs, Min Inter Frame Delay 1.907µs

Resolution (pixels)	Max Double Frame Speed (dfps)	Memory size			Min Double Frame Delay (µs)	Max Shutter
		4GB	8GB	16GB		
		Frames in Memory	Frames in Memory	Frames in Memory		Absolute (µs)
1280 x 1024	1,012	2447	4897	9797	493.923	492.015
1280 x 960	1,079	2611	5224	10450	463.153	461.246
1272 x 952	1,097	2657	5318	10638	455.646	453.738
1260 x 944	1,115	2705	5414	10830	448.2	446.292
1248 x 936	1,134	2755	5512	11028	440.815	438.907
1236 x 924	1,158	2818	5638	11279	431.63	429.723
1224 x 916	1,178	2870	5743	11489	424.384	422.476
1212 x 908	1,198	2924	5851	11705	417.2	415.292
1200 x 900	1,219	2980	5962	11928	410.076	408.169
1188 x 888	1,246	3050	6104	12211	401.215	399.307
1176 x 880	1,268	3110	6222	12448	394.23	392.323
1164 x 872	1,290	3171	6344	12691	387.307	385.4
1152 x 864	1,314	3233	6470	12942	380.446	378.538
1140 x 852	1,344	3313	6630	13263	371.907	370
1128 x 844	1,369	3380	6764	13531	365.184	363.276
1116 x 836	1,394	3449	6902	13807	358.523	356.615
1104 x 828	1,420	3521	7044	14092	351.923	350.015
1092 x 816	1,454	3612	7227	14457	343.707	341.8
1080 x 808	1,482	3688	7379	14762	337.246	335.338
1068 x 800	1,511	3767	7537	15077	330.846	328.938
1056 x 792	1,540	3848	7699	15402	324.507	322.6
1044 x 780	1,579	3952	7908	15819	316.615	314.707
1032 x 772	1,610	4039	8083	16169	310.415	308.507
1020 x 764	1,643	4130	8263	16530	304.276	302.369
1008 x 756	1,676	4223	8450	16904	298.2	296.292
996 x 744	1,720	4343	8690	17384	290.63	288.723
984 x 736	1,756	4444	8892	17787	284.692	282.784
972 x 728	1,793	4548	9100	18205	278.815	276.907
960 x 720	1,831	4656	9316	18637	273	271.092
948 x 708	1,881	4795	9594	19193	265.753	263.846
936 x 700	1,922	4912	9828	19661	260.076	258.169
924 x 692	1,964	5033	10071	20147	254.461	252.553
912 x 684	2,008	5159	10323	20651	248.907	247
900 x 672	2,066	5321	10647	21300	241.984	240.076
888 x 664	2,113	5458	10921	21847	236.569	234.661
876 x 656	2,162	5600	11206	22417	231.215	229.307
864 x 648	2,213	5748	11502	23009	225.923	224.015
852 x 636	2,279	5939	11884	23773	219.323	217.415
840 x 628	2,334	6101	12207	24420	214.169	212.261
828 x 620	2,391	6269	12544	25094	209.076	207.169
816 x 612	2,450	6445	12895	25795	204.046	202.138
804 x 600	2,528	6672	13349	26704	197.769	195.861
792 x 592	2,592	6864	13734	27475	192.876	190.969
780 x 584	2,658	7065	14137	28280	188.046	186.138
768 x 576	2,727	7275	14557	29121	183.276	181.369

756 x 564	2,819	7548	15103	30212	177.323	175.415
744 x 556	2,895	7780	15567	31141	172.692	170.784
732 x 548	2,973	8023	16053	32114	168.123	166.215
720 x 540	3,055	8278	16563	33133	163.615	161.707
708 x 528	3,164	8609	17226	34460	157.984	156.076
696 x 520	3,254	8893	17793	35594	153.615	151.707
684 x 512	3,348	9190	18388	36784	149.307	147.4
672 x 504	3,446	9503	19014	38035	145.061	143.153
660 x 492	3,577	9911	19831	39671	139.753	137.846
648 x 484	3,685	10262	20533	41074	135.646	133.738
636 x 476	3,799	10631	21272	42552	131.6	129.692
624 x 468	3,917	11021	22051	44112	127.615	125.707
612 x 456	4,077	11533	23075	46161	122.63	120.723
600 x 448	4,209	11973	23957	47925	118.784	116.876
588 x 440	4,347	12440	24891	49792	115	113.092
576 x 432	4,492	12934	25880	51770	111.276	109.369
564 x 420	4,689	13587	27186	54383	106.615	104.707
552 x 412	4,852	14152	28316	56644	103.03	101.123
540 x 404	5,024	14753	29518	59049	99.507	97.6
528 x 396	5,205	15393	30799	61611	96.046	94.138
516 x 384	5,451	16243	32500	65014	91.707	89.8
504 x 376	5,656	16984	33982	67978	88.384	86.476
492 x 368	5,873	17776	35568	71150	85.123	83.215
480 x 360	6,102	18626	37267	74550	81.923	80.015
468 x 348	6,417	19762	39541	79098	77.907	76
456 x 340	6,679	20759	41536	83089	74.846	72.938
444 x 332	6,958	21834	43687	87391	71.846	69.938
432 x 324	7,255	22995	46009	92037	68.907	67
420 x 312	7,665	24561	49143	98307	65.215	63.307
408 x 304	8,009	25949	51920	103862	62.415	60.507
396 x 296	8,377	27458	54939	109901	59.676	57.769
384 x 288	8,770	29103	58230	116484	57	55.092
372 x 276	9,321	31348	62722	125470	53.63	51.723
360 x 268	9,784	33360	66747	133522	51.092	49.184
348 x 260	10,283	35572	71173	142377	48.615	46.707
336 x 252	10,820	38012	76056	152143	46.2	44.292
324 x 240	11,584	41391	82816	165667	43.153	41.246
312 x 232	12,229	44465	88967	177971	40.876	38.969
300 x 224	12,930	47895	95830	191700	38.661	36.753
288 x 216	13,692	51739	103520	207083	36.507	34.6
276 x 204	14,796	57164	114375	228798	33.784	31.876
264 x 196	15,734	62202	124455	248961	31.769	29.861
252 x 188	16,765	67937	135930	271915	29.815	27.907
240 x 180	17,901	74504	149069	298200	27.923	26.015
228 x 168	19,584	84027	168123	336316	25.523	23.615
216 x 160	21,028	93130	186337	372750	23.769	21.861
204 x 152	22,640	103798	207682	415449	22.076	20.169
192 x 144	24,445	116413	232921	465938	20.446	18.538
180 x 132	27,208	135462	271036	542183	18.369	16.461
168 x 124	29,612	154502	309131	618388	16.876	14.969
156 x 116	32,354	177862	355869	711885	15.446	13.538
144 x 108	35,499	206957	414083	828335	14.076	12.169
132 x 96	40,548	253992	508192	1016593	12.323	10.415
120 x 88	45,045	304791	609831	1219912	11.092	9.184
108 x 80	50,348	372522	745349	1491003	9.923	8.015
96 x 72	56,669	465653	931687	1863754	8.815	6.907
84 x 60	67,637	638610	1277742	2556006	7.384	5.476
72 x 52	74,971	859667	1720037	3440777	6.661	4.753
60 x 44	74,971	1219165	2439326	4879648	6.661	4.753
48 x 36	74,971	1862613	3726748	7455018	6.661	4.753
36 x 24	74,971	3725226	7453496	14910037	6.661	4.753
24 x 16	74,971	8381760	16770368	33547584	6.661	4.753
24 x 8	74,971	16763520	33540736	67095168	6.661	4.753

Nominal values of speeds and resolutions
***i*-SPEED DF in SIF Optimize Mode, DF sync mode**
Min shutter 1µs, Min Inter Frame Delay 646ns

Resolution (pixels)	Max Double Frame Speed (dfps)	Memory size			Min Double Frame Delay (µs)	Max Shutter
		4GB	8GB	16GB		
		Frames in Memory	Frames in Memory	Frames in Memory		Absolute (µs)
1280 x 1024	1,065	2447	4897	9797	469.2	468.553
1280 x 960	1,136	2611	5224	10450	439.907	439.261
1272 x 952	1,155	2657	5318	10638	432.584	431.938
1260 x 944	1,175	2705	5414	10830	425.323	424.676
1248 x 936	1,195	2755	5512	11028	418.123	417.476
1236 x 924	1,221	2818	5638	11279	409.215	408.569
1224 x 916	1,243	2870	5743	11489	402.153	401.507
1212 x 908	1,265	2924	5851	11705	395.153	394.507
1200 x 900	1,287	2980	5962	11928	388.215	387.569
1188 x 888	1,317	3050	6104	12211	379.63	378.984
1176 x 880	1,341	3110	6222	12448	372.83	372.184
1164 x 872	1,365	3171	6344	12691	366.092	365.446
1152 x 864	1,391	3233	6470	12942	359.415	358.769
1140 x 852	1,423	3313	6630	13263	351.153	350.507
1128 x 844	1,450	3380	6764	13531	344.615	343.969
1116 x 836	1,478	3449	6902	13807	338.138	337.492
1104 x 828	1,507	3521	7044	14092	331.723	331.076
1092 x 816	1,544	3612	7227	14457	323.784	323.138
1080 x 808	1,574	3688	7379	14762	317.507	316.861
1068 x 800	1,606	3767	7537	15077	311.292	310.646
1056 x 792	1,638	3848	7699	15402	305.138	304.492
1044 x 780	1,680	3952	7908	15819	297.523	296.876
1032 x 772	1,715	4039	8083	16169	291.507	290.861
1020 x 764	1,750	4130	8263	16530	285.553	284.907
1008 x 756	1,787	4223	8450	16904	279.661	279.015
996 x 744	1,835	4343	8690	17384	272.369	271.723
984 x 736	1,875	4444	8892	17787	266.615	265.969
972 x 728	1,916	4548	9100	18205	260.923	260.276
960 x 720	1,958	4656	9316	18637	255.292	254.646
948 x 708	2,013	4795	9594	19193	248.323	247.676
936 x 700	2,058	4912	9828	19661	242.83	242.184
924 x 692	2,106	5033	10071	20147	237.4	236.753
912 x 684	2,154	5159	10323	20651	232.03	231.384
900 x 672	2,218	5321	10647	21300	225.384	224.738
888 x 664	2,271	5458	10921	21847	220.153	219.507
876 x 656	2,325	5600	11206	22417	214.984	214.338
864 x 648	2,382	5748	11502	23009	209.876	209.23
852 x 636	2,456	5939	11884	23773	203.553	202.907
840 x 628	2,517	6101	12207	24420	198.584	197.938
828 x 620	2,581	6269	12544	25094	193.676	193.03
816 x 612	2,647	6445	12895	25795	188.83	188.184
804 x 600	2,734	6672	13349	26704	182.83	182.184
792 x 592	2,806	6864	13734	27475	178.123	177.476
780 x 584	2,882	7065	14137	28280	173.476	172.83
768 x 576	2,960	7275	14557	29121	168.892	168.246
756 x 564	3,063	7548	15103	30212	163.215	162.569
744 x 556	3,149	7780	15567	31141	158.769	158.123
732 x 548	3,238	8023	16053	32114	154.384	153.738
720 x 540	3,331	8278	16563	33133	150.061	149.415
708 x 528	3,455	8609	17226	34460	144.707	144.061
696 x 520	3,557	8893	17793	35594	140.523	139.876
684 x 512	3,665	9190	18388	36784	136.4	135.753
672 x 504	3,777	9503	19014	38035	132.338	131.692
660 x 492	3,927	9911	19831	39671	127.307	126.661
648 x 484	4,052	10262	20533	41074	123.384	122.738
636 x 476	4,183	10631	21272	42552	119.523	118.876
624 x 468	4,320	11021	22051	44112	115.723	115.076
612 x 456	4,503	11533	23075	46161	111.015	110.369
600 x 448	4,657	11973	23957	47925	107.353	106.707
588 x 440	4,818	12440	24891	49792	103.753	103.107
576 x 432	4,988	12934	25880	51770	100.215	99.569

564 x 420	5,217	13587	27186	54383	95.83	95.184
552 x 412	5,409	14152	28316	56644	92.43	91.784
540 x 404	5,611	14753	29518	59049	89.092	88.446
528 x 396	5,825	15393	30799	61611	85.815	85.169
516 x 384	6,115	16243	32500	65014	81.753	81.107
504 x 376	6,359	16984	33982	67978	78.615	77.969
492 x 368	6,618	17776	35568	71150	75.538	74.892
480 x 360	6,893	18626	37267	74550	72.523	71.876
468 x 348	7,268	19762	39541	79098	68.784	68.138
456 x 340	7,585	20759	41536	83089	65.907	65.261
444 x 332	7,923	21834	43687	87391	63.092	62.446
432 x 324	8,285	22995	46009	92037	60.338	59.692
420 x 312	8,782	24561	49143	98307	56.923	56.276
408 x 304	9,205	25949	51920	103862	54.307	53.661
396 x 296	9,659	27458	54939	109901	51.753	51.107
384 x 288	10,148	29103	58230	116484	49.261	48.615
372 x 276	10,827	31348	62722	125470	46.169	45.523
360 x 268	11,409	33360	66747	133522	43.815	43.169
348 x 260	12,039	35572	71173	142377	41.523	40.876
336 x 252	12,722	38012	76056	152143	39.292	38.646
324 x 240	13,687	41391	82816	165667	36.523	35.876
312 x 232	14,518	44465	88967	177971	34.43	33.784
300 x 224	15,428	47895	95830	191700	32.4	31.753
288 x 216	16,426	51739	103520	207083	30.43	29.784
276 x 204	17,862	57164	114375	228798	27.984	27.338
264 x 196	19,112	62202	124455	248961	26.153	25.507
252 x 188	20,498	67937	135930	271915	24.384	23.738
240 x 180	22,041	74504	149069	298200	22.676	22.03
228 x 168	24,317	84027	168123	336316	20.553	19.907
216 x 160	26,326	93130	186337	372750	18.984	18.338
204 x 152	28,596	103798	207682	415449	17.476	16.83
192 x 144	31,175	116413	232921	465938	16.03	15.384
180 x 132	35,116	135462	271036	542183	14.23	13.584
168 x 124	38,667	154502	309131	618388	12.923	12.276
156 x 116	42,791	177862	355869	711885	11.676	11.03
144 x 108	47,619	206957	414083	828335	10.492	9.846
132 x 96	55,413	253992	508192	1016593	9.015	8.369
120 x 88	62,680	304791	609831	1219912	7.969	7.323
108 x 80	71,507	372522	745349	1491003	6.984	6.338
96 x 72	82,382	465653	931687	1863754	6.061	5.415
84 x 60	101,721	638610	1277742	2556006	4.907	4.261
72 x 52	121,042	859667	1720037	3440777	4.123	3.476
60 x 44	146,726	1219165	2439326	4879648	3.4	2.753
48 x 36	150,115	1862613	3726748	7455018	3.323	2.676
36 x 24	150,115	3725226	7453496	14910037	3.323	2.676
24 x 16	150,115	8381760	16770368	33547584	3.323	2.676
24 x 8	150,115	16763520	33540736	67095168	3.323	2.676

Nominal values of speeds and resolutions *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF in HQ Optimize Mode, RS sync mode: Min shutter 2.169µs, Max shutter 950ms				
Resolution (pixels)	Max Frame Speed (fps)	Memory size		
		4GB	8GB	16GB
		Frames in Memory	Frames in Memory	Frames in Memory
1280 x 1024	2,021	2447	4897	9797
1280 x 960	2,155	2611	5224	10450
1272 x 952	2,190	2657	5318	10638
1260 x 944	2,227	2705	5414	10830
1248 x 936	2,264	2755	5512	11028
1236 x 924	2,312	2818	5638	11279
1224 x 916	2,351	2870	5743	11489
1212 x 908	2,392	2924	5851	11705
1200 x 900	2,433	2980	5962	11928
1188 x 888	2,487	3050	6104	12211
1176 x 880	2,531	3110	6222	12448
1164 x 872	2,576	3171	6344	12691
1152 x 864	2,622	3233	6470	12942
1140 x 852	2,683	3313	6630	13263
1128 x 844	2,732	3380	6764	13531
1116 x 836	2,783	3449	6902	13807
1104 x 828	2,835	3521	7044	14092
1092 x 816	2,902	3612	7227	14457
1080 x 808	2,958	3688	7379	14762
1068 x 800	3,015	3767	7537	15077
1056 x 792	3,074	3848	7699	15402
1044 x 780	3,150	3952	7908	15819
1032 x 772	3,213	4039	8083	16169
1020 x 764	3,277	4130	8263	16530
1008 x 756	3,344	4223	8450	16904
996 x 744	3,431	4343	8690	17384
984 x 736	3,502	4444	8892	17787
972 x 728	3,576	4548	9100	18205
960 x 720	3,652	4656	9316	18637
948 x 708	3,751	4795	9594	19193
936 x 700	3,833	4912	9828	19661
924 x 692	3,917	5033	10071	20147
912 x 684	4,004	5159	10323	20651
900 x 672	4,118	5321	10647	21300
888 x 664	4,212	5458	10921	21847
876 x 656	4,310	5600	11206	22417
864 x 648	4,410	5748	11502	23009
852 x 636	4,542	5939	11884	23773
840 x 628	4,651	6101	12207	24420
828 x 620	4,764	6269	12544	25094
816 x 612	4,881	6445	12895	25795
804 x 600	5,036	6672	13349	26704
792 x 592	5,163	6864	13734	27475
780 x 584	5,295	7065	14137	28280
768 x 576	5,432	7275	14557	29121
756 x 564	5,614	7548	15103	30212
744 x 556	5,763	7780	15567	31141
732 x 548	5,919	8023	16053	32114
720 x 540	6,082	8278	16563	33133
708 x 528	6,297	8609	17226	34460
696 x 520	6,476	8893	17793	35594
684 x 512	6,661	9190	18388	36784
672 x 504	6,855	9503	19014	38035
660 x 492	7,114	9911	19831	39671
648 x 484	7,328	10262	20533	41074
636 x 476	7,552	10631	21272	42552
624 x 468	7,787	11021	22051	44112
612 x 456	8,101	11533	23075	46161
600 x 448	8,362	11973	23957	47925
588 x 440	8,635	12440	24891	49792
576 x 432	8,922	12934	25880	51770

564 x 420	9,309	13587	27186	54383
552 x 412	9,631	14152	28316	56644
540 x 404	9,969	14753	29518	59049
528 x 396	10,325	15393	30799	61611
516 x 384	10,809	16243	32500	65014
504 x 376	11,212	16984	33982	67978
492 x 368	11,638	17776	35568	71150
480 x 360	12,088	18626	37267	74550
468 x 348	12,705	19762	39541	79098
456 x 340	13,219	20759	41536	83089
444 x 332	13,765	21834	43687	87391
432 x 324	14,345	22995	46009	92037
420 x 312	15,147	24561	49143	98307
408 x 304	15,818	25949	51920	103862
396 x 296	16,535	27458	54939	109901
384 x 288	17,301	29103	58230	116484
372 x 276	18,371	31348	62722	125470
360 x 268	19,270	33360	66747	133522
348 x 260	20,236	35572	71173	142377
336 x 252	21,276	38012	76056	152143
324 x 240	22,751	41391	82816	165667
312 x 232	23,994	44465	88967	177971
300 x 224	25,341	47895	95830	191700
288 x 216	26,804	51739	103520	207083
276 x 204	28,914	57164	114375	228798
264 x 196	30,703	62202	124455	248961
252 x 188	32,663	67937	135930	271915
240 x 180	34,815	74504	149069	298200
228 x 168	37,989	84027	168123	336316
216 x 160	40,701	93130	186337	372750
204 x 152	43,712	103798	207682	415449
192 x 144	47,067	116413	232921	465938
180 x 132	52,166	135462	271036	542183
168 x 124	56,570	154502	309131	618388
156 x 116	61,553	177862	355869	711885
144 x 108	67,218	206957	414083	828335
132 x 96	76,201	253992	508192	1016593
120 x 88	84,087	304791	609831	1219912
108 x 80	93,256	372522	745349	1491003
96 x 72	104,000	465653	931687	1863754
84 x 60	122,180	638610	1277742	2556006
72 x 52	138,592	859667	1720037	3440777
60 x 44	149,769	1219165	2439326	4879648
48 x 36	149,769	1862613	3726748	7455018
36 x 24	149,769	3725226	7453496	14910037
24 x 16	149,769	8381760	16770368	33547584
24 x 8	149,769	16763520	33540736	67095168

Nominal values of speeds and resolutions *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF in QS Optimize Mode, RS sync mode: Min shutter 1µs, Max shutter 950ms				
Resolution (pixels)	Max Frame Speed (fps)	Memory size		
		4GB	8GB	16GB
		Frames in Memory	Frames in Memory	Frames in Memory
1280 x 1024	2,024	2447	4897	9797
1280 x 960	2,159	2611	5224	10450
1272 x 952	2,194	2657	5318	10638
1260 x 944	2,231	2705	5414	10830
1248 x 936	2,268	2755	5512	11028
1236 x 924	2,316	2818	5638	11279
1224 x 916	2,356	2870	5743	11489
1212 x 908	2,396	2924	5851	11705
1200 x 900	2,438	2980	5962	11928
1188 x 888	2,492	3050	6104	12211
1176 x 880	2,536	3110	6222	12448
1164 x 872	2,581	3171	6344	12691
1152 x 864	2,628	3233	6470	12942
1140 x 852	2,688	3313	6630	13263
1128 x 844	2,738	3380	6764	13531
1116 x 836	2,789	3449	6902	13807
1104 x 828	2,841	3521	7044	14092
1092 x 816	2,909	3612	7227	14457
1080 x 808	2,965	3688	7379	14762
1068 x 800	3,022	3767	7537	15077
1056 x 792	3,081	3848	7699	15402
1044 x 780	3,158	3952	7908	15819
1032 x 772	3,221	4039	8083	16169
1020 x 764	3,286	4130	8263	16530
1008 x 756	3,353	4223	8450	16904
996 x 744	3,440	4343	8690	17384
984 x 736	3,512	4444	8892	17787
972 x 728	3,586	4548	9100	18205
960 x 720	3,662	4656	9316	18637
948 x 708	3,762	4795	9594	19193
936 x 700	3,844	4912	9828	19661
924 x 692	3,929	5033	10071	20147
912 x 684	4,017	5159	10323	20651
900 x 672	4,132	5321	10647	21300
888 x 664	4,226	5458	10921	21847
876 x 656	4,324	5600	11206	22417
864 x 648	4,425	5748	11502	23009
852 x 636	4,559	5939	11884	23773
840 x 628	4,668	6101	12207	24420
828 x 620	4,782	6269	12544	25094
816 x 612	4,900	6445	12895	25795
804 x 600	5,056	6672	13349	26704
792 x 592	5,184	6864	13734	27475
780 x 584	5,317	7065	14137	28280
768 x 576	5,455	7275	14557	29121
756 x 564	5,638	7548	15103	30212
744 x 556	5,790	7780	15567	31141
732 x 548	5,947	8023	16053	32114
720 x 540	6,111	8278	16563	33133
708 x 528	6,329	8609	17226	34460
696 x 520	6,509	8893	17793	35594
684 x 512	6,696	9190	18388	36784
672 x 504	6,892	9503	19014	38035
660 x 492	7,154	9911	19831	39671
648 x 484	7,371	10262	20533	41074
636 x 476	7,597	10631	21272	42552
624 x 468	7,835	11021	22051	44112
612 x 456	8,153	11533	23075	46161
600 x 448	8,417	11973	23957	47925
588 x 440	8,694	12440	24891	49792
576 x 432	8,985	12934	25880	51770

564 x 420	9,378	13587	27186	54383
552 x 412	9,704	14152	28316	56644
540 x 404	10,047	14753	29518	59049
528 x 396	10,409	15393	30799	61611
516 x 384	10,902	16243	32500	65014
504 x 376	11,312	16984	33982	67978
492 x 368	11,745	17776	35568	71150
480 x 360	12,204	18626	37267	74550
468 x 348	12,833	19762	39541	79098
456 x 340	13,357	20759	41536	83089
444 x 332	13,915	21834	43687	87391
432 x 324	14,508	22995	46009	92037
420 x 312	15,330	24561	49143	98307
408 x 304	16,017	25949	51920	103862
396 x 296	16,752	27458	54939	109901
384 x 288	17,539	29103	58230	116484
372 x 276	18,640	31348	62722	125470
360 x 268	19,566	33360	66747	133522
348 x 260	20,563	35572	71173	142377
336 x 252	21,637	38012	76056	152143
324 x 240	23,164	41391	82816	165667
312 x 232	24,454	44465	88967	177971
300 x 224	25,855	47895	95830	191700
288 x 216	27,379	51739	103520	207083
276 x 204	29,585	57164	114375	228798
264 x 196	31,461	62202	124455	248961
252 x 188	33,522	67937	135930	271915
240 x 180	35,792	74504	149069	298200
228 x 168	39,156	84027	168123	336316
216 x 160	42,043	93130	186337	372750
204 x 152	45,264	103798	207682	415449
192 x 144	48,872	116413	232921	465938
180 x 132	54,393	135462	271036	542183
168 x 124	59,198	154502	309131	618388
156 x 116	64,676	177862	355869	711885
144 x 108	70,960	206957	414083	828335
132 x 96	81,047	253992	508192	1016593
120 x 88	90,027	304791	609831	1219912
108 x 80	100,619	372522	745349	1491003
96 x 72	113,240	465653	931687	1863754
84 x 60	135,135	638610	1277742	2556006
72 x 52	149,769	859667	1720037	3440777
60 x 44	149,769	1219165	2439326	4879648
48 x 36	149,769	1862613	3726748	7455018
36 x 24	149,769	3725226	7453496	14910037
24 x 16	149,769	8381760	16770368	33547584
24 x 8	149,769	16763520	33540736	67095168

Nominal values of speeds and resolutions *i*-SPEED FS in FS Optimize Mode, RS sync mode Min shutter 200ns, Max shutter 950ms				
Resolution (pixels)	Max Frame Speed (fps)	Memory size		
		4GB	8GB	16GB
		Frames in Memory	Frames in Memory	Frames in Memory
1280 x 1024	2,131	2447	4897	9797
1280 x 960	2,273	2611	5224	10450
1272 x 952	2,311	2657	5318	10638
1260 x 944	2,351	2705	5414	10830
1248 x 936	2,391	2755	5512	11028
1236 x 924	2,443	2818	5638	11279
1224 x 916	2,486	2870	5743	11489
1212 x 908	2,530	2924	5851	11705
1200 x 900	2,575	2980	5962	11928
1188 x 888	2,634	3050	6104	12211
1176 x 880	2,682	3110	6222	12448
1164 x 872	2,731	3171	6344	12691
1152 x 864	2,782	3233	6470	12942
1140 x 852	2,847	3313	6630	13263
1128 x 844	2,901	3380	6764	13531
1116 x 836	2,957	3449	6902	13807
1104 x 828	3,014	3521	7044	14092
1092 x 816	3,088	3612	7227	14457
1080 x 808	3,149	3688	7379	14762
1068 x 800	3,212	3767	7537	15077
1056 x 792	3,277	3848	7699	15402
1044 x 780	3,360	3952	7908	15819
1032 x 772	3,430	4039	8083	16169
1020 x 764	3,501	4130	8263	16530
1008 x 756	3,575	4223	8450	16904
996 x 744	3,671	4343	8690	17384
984 x 736	3,750	4444	8892	17787
972 x 728	3,832	4548	9100	18205
960 x 720	3,916	4656	9316	18637
948 x 708	4,026	4795	9594	19193
936 x 700	4,117	4912	9828	19661
924 x 692	4,212	5033	10071	20147
912 x 684	4,309	5159	10323	20651
900 x 672	4,436	5321	10647	21300
888 x 664	4,541	5458	10921	21847
876 x 656	4,651	5600	11206	22417
864 x 648	4,764	5748	11502	23009
852 x 636	4,912	5939	11884	23773
840 x 628	5,035	6101	12207	24420
828 x 620	5,162	6269	12544	25094
816 x 612	5,295	6445	12895	25795
804 x 600	5,469	6672	13349	26704
792 x 592	5,613	6864	13734	27475
780 x 584	5,763	7065	14137	28280
768 x 576	5,920	7275	14557	29121
756 x 564	6,126	7548	15103	30212
744 x 556	6,297	7780	15567	31141
732 x 548	6,476	8023	16053	32114
720 x 540	6,663	8278	16563	33133
708 x 528	6,909	8609	17226	34460
696 x 520	7,115	8893	17793	35594
684 x 512	7,330	9190	18388	36784
672 x 504	7,555	9503	19014	38035
660 x 492	7,854	9911	19831	39671
648 x 484	8,103	10262	20533	41074
636 x 476	8,365	10631	21272	42552
624 x 468	8,640	11021	22051	44112
612 x 456	9,006	11533	23075	46161
600 x 448	9,313	11973	23957	47925
588 x 440	9,636	12440	24891	49792
576 x 432	9,976	12934	25880	51770

564 x 420	10,433	13587	27186	54383
552 x 412	10,817	14152	28316	56644
540 x 404	11,222	14753	29518	59049
528 x 396	11,650	15393	30799	61611
516 x 384	12,229	16243	32500	65014
504 x 376	12,717	16984	33982	67978
492 x 368	13,235	17776	35568	71150
480 x 360	13,785	18626	37267	74550
468 x 348	14,534	19762	39541	79098
456 x 340	15,169	20759	41536	83089
444 x 332	15,845	21834	43687	87391
432 x 324	16,568	22995	46009	92037
420 x 312	17,562	24561	49143	98307
408 x 304	18,408	25949	51920	103862
396 x 296	19,316	27458	54939	109901
384 x 288	20,293	29103	58230	116484
372 x 276	21,652	31348	62722	125470
360 x 268	22,815	33360	66747	133522
348 x 260	24,074	35572	71173	142377
336 x 252	25,440	38012	76056	152143
324 x 240	27,368	41391	82816	165667
312 x 232	29,030	44465	88967	177971
300 x 224	30,849	47895	95830	191700
288 x 216	32,844	51739	103520	207083
276 x 204	35,714	57164	114375	228798
264 x 196	38,212	62202	124455	248961
252 x 188	40,983	67937	135930	271915
240 x 180	44,067	74504	149069	298200
228 x 168	48,616	84027	168123	336316
216 x 160	52,631	93130	186337	372750
204 x 152	57,167	103798	207682	415449
192 x 144	62,320	116413	232921	465938
180 x 132	70,194	135462	271036	542183
168 x 124	77,288	154502	309131	618388
156 x 116	85,526	177862	355869	711885
144 x 108	95,168	206957	414083	828335
132 x 96	110,732	253992	508192	1016593
120 x 88	125,240	304791	609831	1219912
108 x 80	142,857	372522	745349	1491003
96 x 72	164,556	465653	931687	1863754
84 x 60	203,125	638610	1277742	2556006
72 x 52	241,635	859667	1720037	3440777
60 x 44	292,792	1219165	2439326	4879648
48 x 36	342,105	1862613	3726748	7455018
36 x 24	342,105	3725226	7453496	14910037
24 x 16	342,105	8381760	16770368	33547584
24 x 8	342,105	16763520	33540736	67095168

Nominal values of speeds and resolutions *i*-SPEED DF in SIF Optimize Mode, RS sync mode Min shutter 1µs, Max shutter 950ms				
Resolution (pixels)	Max Frame Speed (fps)	Memory size		
		4GB	8GB	16GB
		Frames in Memory	Frames in Memory	Frames in Memory
1280 x 1024	2,131	2447	4897	9797
1280 x 960	2,273	2611	5224	10450
1272 x 952	2,311	2657	5318	10638
1260 x 944	2,351	2705	5414	10830
1248 x 936	2,391	2755	5512	11028
1236 x 924	2,443	2818	5638	11279
1224 x 916	2,486	2870	5743	11489
1212 x 908	2,530	2924	5851	11705
1200 x 900	2,575	2980	5962	11928
1188 x 888	2,634	3050	6104	12211
1176 x 880	2,682	3110	6222	12448
1164 x 872	2,731	3171	6344	12691
1152 x 864	2,782	3233	6470	12942
1140 x 852	2,847	3313	6630	13263
1128 x 844	2,901	3380	6764	13531
1116 x 836	2,957	3449	6902	13807
1104 x 828	3,014	3521	7044	14092
1092 x 816	3,088	3612	7227	14457
1080 x 808	3,149	3688	7379	14762
1068 x 800	3,212	3767	7537	15077
1056 x 792	3,277	3848	7699	15402
1044 x 780	3,360	3952	7908	15819
1032 x 772	3,430	4039	8083	16169
1020 x 764	3,501	4130	8263	16530
1008 x 756	3,575	4223	8450	16904
996 x 744	3,671	4343	8690	17384
984 x 736	3,750	4444	8892	17787
972 x 728	3,832	4548	9100	18205
960 x 720	3,916	4656	9316	18637
948 x 708	4,026	4795	9594	19193
936 x 700	4,117	4912	9828	19661
924 x 692	4,212	5033	10071	20147
912 x 684	4,309	5159	10323	20651
900 x 672	4,436	5321	10647	21300
888 x 664	4,541	5458	10921	21847
876 x 656	4,651	5600	11206	22417
864 x 648	4,764	5748	11502	23009
852 x 636	4,912	5939	11884	23773
840 x 628	5,035	6101	12207	24420
828 x 620	5,162	6269	12544	25094
816 x 612	5,295	6445	12895	25795
804 x 600	5,469	6672	13349	26704
792 x 592	5,613	6864	13734	27475
780 x 584	5,763	7065	14137	28280
768 x 576	5,920	7275	14557	29121
756 x 564	6,126	7548	15103	30212
744 x 556	6,297	7780	15567	31141
732 x 548	6,476	8023	16053	32114
720 x 540	6,663	8278	16563	33133
708 x 528	6,909	8609	17226	34460
696 x 520	7,115	8893	17793	35594
684 x 512	7,330	9190	18388	36784
672 x 504	7,555	9503	19014	38035
660 x 492	7,854	9911	19831	39671
648 x 484	8,103	10262	20533	41074
636 x 476	8,365	10631	21272	42552
624 x 468	8,640	11021	22051	44112
612 x 456	9,006	11533	23075	46161
600 x 448	9,313	11973	23957	47925
588 x 440	9,636	12440	24891	49792
576 x 432	9,976	12934	25880	51770

564 x 420	10,433	13587	27186	54383
552 x 412	10,817	14152	28316	56644
540 x 404	11,222	14753	29518	59049
528 x 396	11,650	15393	30799	61611
516 x 384	12,229	16243	32500	65014
504 x 376	12,717	16984	33982	67978
492 x 368	13,235	17776	35568	71150
480 x 360	13,785	18626	37267	74550
468 x 348	14,534	19762	39541	79098
456 x 340	15,169	20759	41536	83089
444 x 332	15,845	21834	43687	87391
432 x 324	16,568	22995	46009	92037
420 x 312	17,562	24561	49143	98307
408 x 304	18,408	25949	51920	103862
396 x 296	19,316	27458	54939	109901
384 x 288	20,293	29103	58230	116484
372 x 276	21,652	31348	62722	125470
360 x 268	22,815	33360	66747	133522
348 x 260	24,074	35572	71173	142377
336 x 252	25,440	38012	76056	152143
324 x 240	27,368	41391	82816	165667
312 x 232	29,030	44465	88967	177971
300 x 224	30,849	47895	95830	191700
288 x 216	32,844	51739	103520	207083
276 x 204	35,714	57164	114375	228798
264 x 196	38,212	62202	124455	248961
252 x 188	40,983	67937	135930	271915
240 x 180	44,067	74504	149069	298200
228 x 168	48,616	84027	168123	336316
216 x 160	52,631	93130	186337	372750
204 x 152	57,167	103798	207682	415449
192 x 144	62,320	116413	232921	465938
180 x 132	70,194	135462	271036	542183
168 x 124	77,288	154502	309131	618388
156 x 116	85,526	177862	355869	711885
144 x 108	95,168	206957	414083	828335
132 x 96	110,732	253992	508192	1016593
120 x 88	125,240	304791	609831	1219912
108 x 80	142,857	372522	745349	1491003
96 x 72	164,556	465653	931687	1863754
84 x 60	203,125	638610	1277742	2556006
72 x 52	241,635	859667	1720037	3440777
60 x 44	292,792	1219165	2439326	4879648
48 x 36	299,539	1862613	3726748	7455018
36 x 24	299,539	3725226	7453496	14910037
24 x 16	299,539	8381760	16770368	33547584
24 x 8	299,539	16763520	33540736	67095168

Trigger	
Trigger input	Position: User controllable, variable in 10% steps as follows: 0% (recording stops one full buffer length after the trigger, so video clip starts at trigger moment) 100% (recording stops immediately, preserving previous video so video clip ends at trigger moment) Edge: Programmable in menu system The trigger point is also controllable in frames
Trigger output	Edge: Rising edge is trigger Duration: 1us high period approx. Rise time: < 50ns Missed frames: For synchronised cameras only, daisy chain operation will not cause any missed frames at the hand over point
Advanced Trigger modes	Record on command (ROC), Burst record on command (BROC)

Synchronisation	
Sync output	Edge: Rising edge signifies start of frame period Frequency: Frequency equals frame rate Rise time: <50ns Duration: 1us high period (approximate)
Sync input	Edge: Programmable in menu system Frequency: Frequency equals frame rate The camera will return to internal syncs at the nearest available frame rate approx 50ms after loss of external sync Camera will lock to arbitrary sync speeds. Shutter is controllable in time, rather than ratio when non-standard sync speeds are used. The sync input port permits the camera to be locked to an incoming signal from the PC software DAQ box Minimum sync lock speed is 24Hz

Dynamic range extension	
Type	Built in to CMOS Imager
Levels	Off, 1 to 4

Enhance	
Type	2 pole, 2 dimensional
Levels	Off, 1, 2, 3 10

Zoom	
Type	Type 2 dimensional with smoothing
Levels	Continuously variable, (1 pixel and 1 line granularity)
Smoothing	Bilinear interpolation, 4 coefficient, 2 x 2
Automatic zoom	The image will automatically be magnified or minified to fill the screen unless in economy mode
User zoom	The user is able to zoom in on an image in order to see more clearly
Zoom application	User zoom may be applied to both recorded and live images, but the image recorded into memory will be taken from the unzoomed area of the sensor chip. The area of the chip used will be determined by the economy mode setting and any windowing caused by frame speed increase
User pan	User pan (H and V) facilities will be provided
Limit	The zoom engine will be limited to the range of 1:1.7 to 30:1

Shutter	
Range	Frame time to 2.16µS (HQ mode) Frame time to 1µS (QS mode) Frame time to 0.2µS (FS mode, *i*-SPEED FS only)
Control	The shutter may be controlled either relatively, as a ratio of frame time or absolutely, as a number of microseconds, selected by menu setting. When external synchronisation or Random Snapshot is used, control will be absolute in microseconds.

Video update for Controller Display Unit	
Refresh rate	The LCD will be refreshed at 60Hz, regardless of video or graphics activity
Playback rate	Video may be played back at speeds from stop frame up to 3,840Hz
Viewfinder mode	At all times, except during playback, video from the sensor will be displayed on the screen at an update rate of 30Hz, with a refresh rate or 60Hz. At sensor speeds below 30Hz, update rate will be equal to sensor speed.

Fixed pattern noise correction	
Resolution	Full resolution of CMOS sensor
Effectiveness	Correction to 0.1%

White balance	
Types	Auto white balance, single shot operation, no time limit on hold, and pre-set options
Range	To correct for daylight, fluorescent light, 60W mains tungsten (Angle poise) and the full range of Olympus light sources.
Preset Options	Tungsten 60W, Halogen 1kW, Daylight, Xenon, Metal Halide, UHP.

Compact Flash card interface	
File type - Stills	Stills are saved as *.JPG (compressed) or *.BMP (uncompressed). Compression is JPEG, with user settable compression ratio. Files are saved at the highest available resolution.
File type - Movies	Movies are saved as *.hsv (compressed) or *.hsv (uncompressed). Compression is Motion JPEG with user settable compression ratio. Audio channel is not included. Files are saved at the highest available resolution.
File conversion	*i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF PC software or viewer software can convert from .hsv to .avi
Filing system	FAT 32 file system, compatible with Windows 2000/XP/Vista.
Data	The user data and other information is also saved to the CF card.
Card functions	Format, delete file, select clip start and end
Save from the measurement screen	A still image can be saved from the measurement screen. The saved image will be a bitmap in 800 x 600 resolution with graphical overlay included. Image processing is included.
Graphical overlay	Only the permanent text will be included - when available. Exception when saving measurement: full SVGA graphics will be saved with image

Real time clock	
Purpose	The system will retain the time of day and date while the power is switched off
Retention time	The battery will power the clock for approx. 5 years
Battery type	Silver oxide coin cell

IRIG timing (*i*-SPEED FS only)	
IRIG standard supported	IRIG-B122
Amplitude	0.1Vp-p min, 8.0Vp-p max
Modulation ratio	2:1 min, 4:1 max
Accuracy	±5µs (over full operational temperature range)
Sync offset range	0 > 95% of frame period
Cable delay range	0 > 65,000µs
Time to achieve accuracy	Full accuracy will be achieved in less than 1 minute
Data output	.irg text file recording frame number, IRIG time and signal status And optionally Permanent text added to each frame of video

❍ Environmental

Temperature	Operation: 0°C to +40°C Storage: 20°C to +60°C This camera contains sensitive electronic parts which could be damaged by operation at extreme temperatures. To prevent this, the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is equipped with internal temperature sensors. If the internal temperature approaches the safe working limit, the camera will display a warning box. If this is ignored, the camera will automatically shut down. The warning is displayed at 5 degrees Celsius before the limit is reached. If the cooling system is operating correctly, the limit corresponds to an ambient of approximately 65 degrees Celsius
Pressure	71kPa to 106kPa
Relative humidity	95% at 40°C non-condensing
Fluid ingress	All items: No resistance to fluid ingress
Attitude of operation	All items will be capable of operation in any orientation
Attitude of storage / transit	All items will be capable of storing / transporting in any orientation

12.2 Controller Display Unit (CDU)

Dimensions	
Size	W 273mm x H 214mm x D 51mm nominal
Weight	1.5kg nominal
Stand	A flip-out stand with ratchet positions of: -3°, 42°, 87°, 132°, 177°. When in the 177° position, the stand can be used as a hanger.
Stability	The unit either resting on its base or in any angled position on a clean lab bench surface will not rock or slide when the buttons are operated, or when tilted at an angle of 10° in any direction
Strap	A strap located across the back of the unit enables single handed holding. Adjustable by Velcro
Tripod mounting	1x ¼ inch Whitworth located in rear, approx at centre of gravity
Connector	
Type	Standard LVDS connector, 26 way MDR
Electrical	
Input voltage	5V ± 10%, 12V ± 10%
Input power	<2W, <8W at nominal voltages
Resolution	800 x 600
Brightness	350 cd/m^2

12.3 Cables

Ethernet cable	
Length	3m
Cable type	Category 6 STP or FTP
Connectors	RJ45

Composite video cable	
Length	2m
Cable type	Coax RG59 B/U
Impedance	75 ohm
Connectors	BNC

S-Video video cable	
Length	2m
Cable type	Twin Coax
Impedance	75 ohm
Connectors	4 pin min*i*-DIN

Controller cable (2 lengths)	
Length	3m standard (10m optional accessory)
Cable type	Multicore, double screened
Connectors	Overmoulded LVDS, 26 way MDR

Feature connector cable	
Length	2.2m overall, bound length 2.0m, tail length 0.2m
Cable type	Multiple coaxes in a plastic sheath and overall screen, with breakout moulding
Camera connector	Lemo series 3B 18 way. FGG 3B 318 CLAD92Z
User equipment connector	5x BNC jack
Cable marking	Appropriate BNC 'tails' printed and colour coded as follows: TRIG IN - Blue TRIG OUT - Green SYNC IN - Purple SYNC OUT - Grey REMOTE POWER - Red EXPOSURE OUT - Orange

FS Feature connector cable	
Length	2.2m overall, bound length 2.0m, tail length 0.2m
Cable type	Multiple coaxes in a plastic sheath and overall screen, with breakout moulding
Camera connector	Lemo series 3B 18 way. FGG 3B 318 CLAD92Z
User equipment connector	5x BNC jack
Cable marking	Appropriate BNC 'tails' printed and colour coded as follows: IRIG IN - White TRIG OUT - Green SYNC IN - Purple SYNC OUT - Grey REMOTE POWER - Red EXPOSURE OUT - Orange

12.4 Power supply

Dimensions	
Size	L 167mm x W 65mm x H 37mm nominal
Weight	650g nominal
Mains input	
Socket type	IEC 320 C6
Fuse	Internal, not user replaceable
Power output	
Lead length	1.8m nominal
Connector	Lemo series 2B 6 way. FGG 2B 306 CLAD52Z
Electrical	
Input	94–264VAC, 47-63Hz
Output	19VDC, 120W

12.5 Trigger switch

Dimensions	
Size	L 90mm x 20mm diameter nominal
Weight	60g nominal
Cable	Integral, black, 2m nominal length, with strain relief
Connector	BNC with strain relief
Switch	Press to close, momentary, high-G, shock resistant
Operation	Thumb press

12.6 Internal memory upgrade

i-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF has a maximum internal memory capacity of 16GB. Upgrades from 4GB to 8GB and 4GB or 8GB to 16GB are available, fitted at Olympus Service Centres.

12.7 Regulatory Status

CE

This mark on the *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera indicates conformity with the requirements of EC Directives 89/336/EEC relating to electromagnetic compatibility and for the 19VDC power supply, compliance with Directive 73/23/EEC as amended by 93/68/EEC, relating to electrical equipment designed for use within certain limits (Low Voltage Directive). The *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF camera has been designed and tested to meet the requirements of the following standards:

EN 61000-6-4:2001 EMC Emissions
EN 61000-6-2:2005 EMC Immunity
EN 61010-1:2001 Electrical Safety

12.8 G-rating

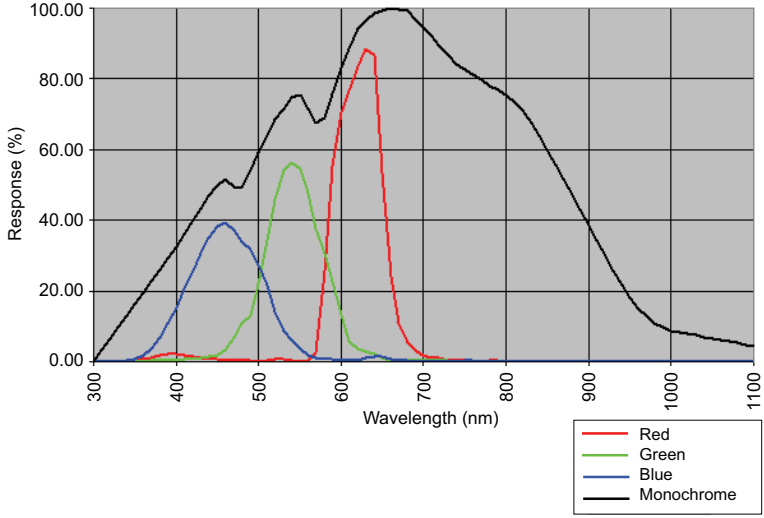
CDU	Not rated
Power supply unit	Not rated
i-SPEED TR* *i*-SPEED 3* *i*-SPEED FS* *i*-SPEED DF*	Shock test to IEC 68-2-27 Test Ea Test level: 100G Pulse duration: 11ms Bump test to IEC 68-2-29 Test Eb Test level: 100G Pulse duration: 2ms

***Note**: These ratings only apply to cameras that are sold and identified as being high-G rated. These cameras are identified with the letters HG on their serial number label.

12.9 Compatibility

Interchangeability	
Any item in the standard set or accessories may be changed for another identical item and the system will still function correctly.	
External compatibility	
Light sources	ILH-2 series, ILK-7 series
Borescopes	Series 5 Borescopes, IFxD4 Fiberscopes, IFxC5 Fiberscopes
Lenses	Standard range of F-mount lenses: 28mm F2.8 50mm F1.4 85mm F1.4 28-75mm F2.8 70-300mm F4-5.6
TV monitors	PAL, NTSC and auto selecting video monitors
Networking	Switches, routers, hubs Speeds: 10MHz, 100MHz, Gigabit

12.10 Spectral response curves



12.11 End of life

In accordance with European Directive 2002/96/EC on Waste Electrical and Electronic Equipment, this symbol indicates that the product must not be disposed of as unsorted municipal waste, but should be collected separately. This product contains a clock backup battery and must be returned to an approved Olympus service centre for disposal at the end of its life.

The emergency backup battery is a customised Lithium Ion unit and should not be replaced with any other battery, even if it looks the same and is the same size. It is a high energy unit and must be treated with care.

The emergency backup battery should only be charged in the camera or with a charger specifically recommended by Olympus.

The emergency backup battery must never be:

short circuited, punctured, dismantled, physically shocked or deformed, heated above 60°C, cooled below -20°C, disposed of in fire, immersed in liquid.

The Olympus *i*-SPEED TR, *i*-SPEED 3, *i*-SPEED FS, *i*-SPEED DF is Made in the UK by KeyMed, an Olympus group company.

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