STV0681+VV6411/6500

DUAL-MODE DIGITAL CAMERA CHIPSET

DESCRIPTION

STMicroelectronics Imaging Division has produced the camera co-processor STV0681 which, used with VV6411/6500 as part of a low cost dual-mode camera chipset, allows a new line of low cost cameras or toy products to be brought to the market. STV0681 is a mask ROM version of STV680B, programmed with v3.00 Firmware.

FEATURES

ST have maintained the standard features already available in the successful STV068B chipset, including:

- Support for VV6411 (CIF) and VV6500 (VGA) CMOS imaging sensors.
- Support for SDRAM sizes 16MBit (up to 20 CIF images) or 64Mbit (up to 80 CIF or 26 VGA images).
- Low resolution “economy” mode allows for more images to be stored.
- High frame rate web cam (tethered video) over USB.
- Audio record/playback and “Delete Last” function
- Custom sounds playback (e.g. “Talking” or “Musical” camera)
- Support for an OEM Flashgun module
- Automatic anti-flicker exposure control.
- Image up load over RS232 or USB.
- Driver support for Win98/Win2k/WinME and MacOS 8.6/9.0/9.1.
- Continuous capture while untethered (except when Flashgun enabled) and downloading to AVI file format
- Power-saving “stand-by” mode which maintains memory contents, as well as generally low power consumption.
- Simple user interface including 2 buttons, status LCD display, and buzzer.
- Evaluation Kit (EVK) available.
- Software Development Kit (SDK) allows OEM PC Software applications to be written.
- Quick Power Down (by holding Mode Button).
- “Delete Last” Function

Audio Record and Playback

The enhanced features included in STV0681 allow audio memos to be recorded at a sampling rate of 11kHz, by adding a microphone and comparator chip, and by utilizing the pre-amplifier included in VV6411/6500 Sensors.

These sounds can be uploaded to the PC over USB or RS232, and played back using a Software application developed by the OEM using the SDK. Demonstration PC software with source code is available with the Evaluation Kit (EVK). With suitable OEM software, the camera could even be used to record comments about pictures or video clips in a “dictaphone” fashion, with the audio commentary played back when viewing the pictures/video.

Recorded audio sounds can also be played back on the camera, with the addition of an amplifier chip and speaker or headphone socket.

By auto-detecting hardware, STV0681 will only enable these additional functions if audio hardware is fitted. Actual hardware implementation is the subject of a separate STV0681 Reference design (see *Chapter 13*).

Evaluation Kit and Reference Design

Evaluation kits are available for STV0681 features. Precise design guidelines are available from ST as a reference design manual (see *Chapter 13*).

Note: Simultaneous audio record and continuous video capture is not possible.

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Document Revision History

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Revision	Draft	Date	Comments
A	1.0	May 2001	Original release (product preview)
B	4.0	April 2002	Document status updated to datasheet. Major changes : removal of all mentions to sensors referenced VV6410 and VV6444

1 Introduction

1.1 Digital camera chipset

1.1.1 General

This document describes the features and functionality of a CMOS chipset, comprising an STMicroelectronics (ST) CIF or VGA resolution sensor and an STV0681 companion processor, as well as outlining what peripheral components are required/supported in order to complete a camera using the chipset. Such a camera is particularly suited to dual-mode digital stills or toy applications.

1.1.2 Stills capture and image upload

In stills mode, the camera stores raw image data in memory. The camera carries out no colour processing, ensuring its simplicity and low cost. Subsequent upload of raw data to a PC or Macintosh for processing is done through an RS232 or USB interface, through demo software, a TWAIN driver, or OEM custom application. The license to use the colour algorithm (embedded in the PC or Mac driver software) is included in the price of the chipset.

1.1.3 Webcam Video over USB

A video option is provided, when tethered through USB, which can allow for Video for Microsoft Windows™ applications, and ‘video clips’ can be recorded while untethered by continuously capturing images while in ‘Continuous’ mode, then downloaded to the PC for playback, using software to create an AVI file.

1.1.4 Audio features

The STV0681 allows audio memos to be recorded at a sampling rate of 11kHz. these sounds can be uploaded to the PC over USB or RS232 and played on the PC, or can be replayed on the camera.

With audio playback hardware fitted to the camera, it is possible to download a set of up to 20.WAV file “sound bites”, to store in SDRAM, which can each be linked to a particular camera function. This allows for camera “Theme Music”, custom sounds such as an imitation shutter “Click-Whirr”, or for certain functions to “talk” to the user, e.g. “Nice picture!”.

This has limitless possibilities for OEM language customizing or licensed character cameras. Downloading of sounds is possible using an OEM application developed using the SDK, and a demonstration PC application with source code is available with the EVK. Sounds are stored in SDRAM and will therefore reduce the number of images/amount of audio which can be stored, STV0681 calculates the remaining memory and displays the number of images left. Sounds can only be stored when untethered while battery power is maintained.

1.1.5 Flashgun support

The addition of an OEM flashgun module increases the camera capabilities and improves low light image quality. STV0681 flashgun support includes modified exposure control, an enable input and a correctly timed trigger output. Although it remains the responsibility of the OEM to source a suitable Flashgun module, advice on hardware interfacing, flash charge sensing, and required flashgun energy are given in a separate Flashgun Application Note (AN1312), please contact ST for details.

1.1.6 “Delete Last” function

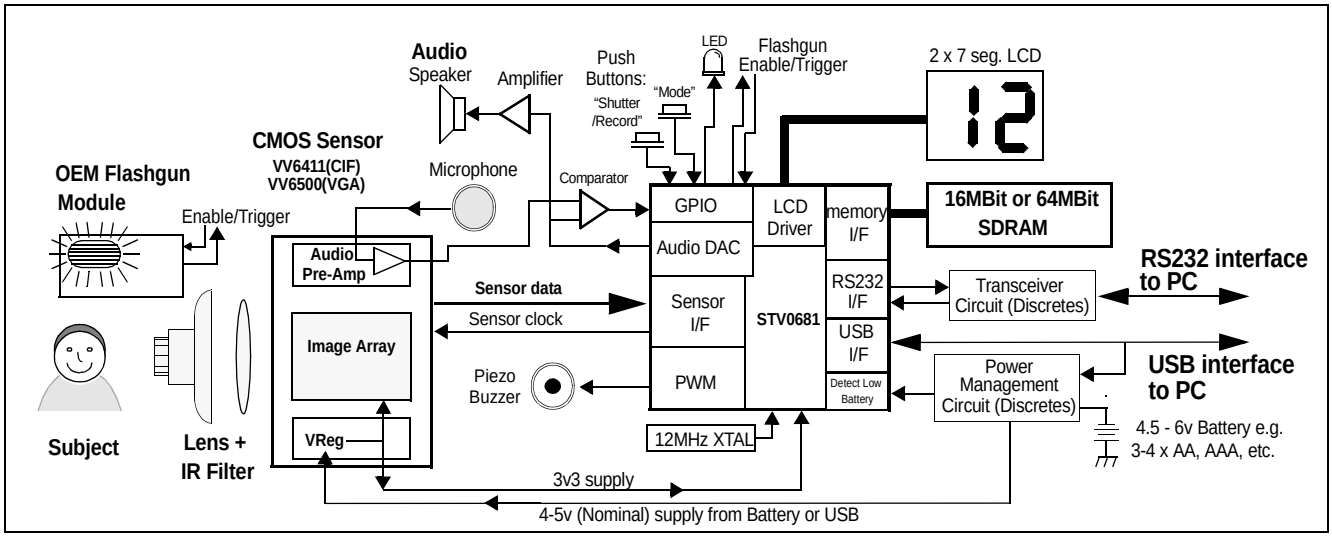
An additional user interface function is available in STV0681 with either audio record or playback hardware fitted, which allows the user to delete the last image or continuous clip to be captured, or the last audio memo to be recorded. The standard “Clear all” (“CL”) function remains, whether or not audio hardware is fitted.

1.1.7 Backward compatibility with STV0680B

STV0681 is electrically and functionally compatible with cameras which have been designed for STV0680B, and uses the same PC/Mac drivers, however the change of device pinout means that some PCB re-design will be required.

Precise design guidelines are available from ST as a reference design (see *Chapter 13*). A software development kit (SDK) for PC is available from ST, to interface to the camera and provide the basis for developing a custom software application for stills and/or video, which includes colour processing software.

Figure 1: Typical camera system block diagram



1.2 Sensor choices

The following sensors are supported:

Table 1: Sensor choices with STV0681

Sensor	Resolution	Sensor supply voltage
VV6411	CIF (352 x 288)	3.3V
VV6500	VGA (640 x 480)	

1.3 Key system features

The key features of a typical camera based on the STV0681 chipset are as follows:

1.3.1 Image features

- Support for CIF resolution sensor (VV6411) - 352 x 288 pixels
- Support for VGA resolution sensor (VV6500) - 640 x 480 pixels
- 80 picture storage capacity possible for CIF, with 64MB memory
- 26 picture storage capacity for VGA, with 64MBit memory
- A greater number of images can be stored when ‘Low’ resolution mode is enabled (e.g. 80 QCIF images with 16Mbit memory, 107 QVGA images with 64Mbit memory). See *Table 2*.
- Automatic anti-flicker exposure and gain control
- Support for flashgun.

1.3.2 User features on camera

- Self-timer mode allows a picture to be captured after several seconds.
- Twin 7 segment LCD panel supported - showing number of pictures left, and modes.
- Picture counter helps the user to know how much memory is left.
- Un-tethered ‘Continuous’ mode allows capture of image sequences for storage in memory and subsequent download to PC.
- Piezo buzzer indicates a number of useful events to the user, e.g. whether enough light is present for picture capture, etc.
- Indicator LED.
- “Clear all” function clears camera.
- “Low Resolution” mode increases number of images which can be captured by reducing image resolution.
- Audio Record function (if audio record hardware detected) allows sounds to be recorded.
- Audio Playback function (if audio playback hardware fitted) allows sounds which have been recorded to be played back.
- “Delete last” function allows user to delete audio memos, pictures or continuous clips, deletion must be carried out “most reset first”.
- Camera can be configured by the user to play custom sounds at certain functions, using a PC application.
- “Go to sleep” function, whereby the camera can be put into standby mode while untethered.

1.3.3 User features on PC software

PC software allows a number of features, including fast download of thumbnail images for picture selection, and automatic detection and correction of sensor defects. The driver compatibility includes:

- TWAIN driver to suit all TWAIN compatible imaging applications
- Video for Microsoft Windows™ PC driver for tethered video mode (through USB), available at all resolutions, with fastest framerates at QCIF resolution
- AVI video file creation from image sequences captured in 'continuous' mode
- Quicktime Video driver and Adobe Photoshop stills plug-in for Mac

Custom OEM PC software can be developed by using the SDK (for SDK availability, contact ST), to upload thumbnails/still images or 'continuous' images, e.g. for AVI file creation.

The SDK (version 2.90 or later) allows for:

- the OEM to write a custom application for uploading sound memos, based on the example LCDC demo software.
- the OEM to write a custom application for downloading custom sounds to the camera, based on the example CustomSound software.

1.3.4 Power management features and USB compliance

- Retention of pictures, recorded sounds, and downloaded custom sounds with extremely low power operation, which appears to the user as if the camera is "switched off".
- Auto power-off after 30sec with no user activity
- Operates from 4.5-6V battery, although system voltage is 5V or 3.3V, dependant on sensor.
- Low battery detection
- Dependant on hardware configuration, switch-over to USB power supply is supported, to allow the device to operate with low batteries or without batteries, when connected to USB.
- Full USB compliance requirements are listed in the USB specification, however, in a camera designed using this chipset, the following must at least be included: (a) an SDRAM with sufficiently low self-refresh current, (b) USB inrush protection circuitry, to maintain sufficient supply voltage to the 5V sensor. See *Section 6* for further details.

1.3.5 General features

- High speed picture/sounds upload to PC/Mac over USB
- ST Colour processing algorithms included under license (as part of drivers/SDK)
- USB or RS232 serial interface options, and VfW / TWAIN driver support.

2 Detailed features

2.1 Sensor type and image formats

The sensor type is auto-detected by STV0681, which ensures that the correct sensor timing is enabled, and the correct image resolutions are enabled, as shown in *Table 2*.

For stills photography, 'High' or 'Low' resolution mode can be selected, to give CIF or QCIF pictures from a CIF sensor, and VGA or QVGA from a VGA sensor (see *Table 2*). Reduced resolution allows for storage of more images. Images captured in both 'High' and 'Low' resolution can be stored in camera memory at the same time. Therefore there is no need for images stored in memory to be cleared before changing image resolution.

Where USB is connected, the host PC software (through a Video for Microsoft Windows™ driver) can activate tethered video mode, regardless of the user inputs to the camera buttons. In this case, the image resolution is controlled by the PC driver.

Note: When tethered VfW video (PC) or Quicktime driver (Mac) is activated, all images or recorded sounds or video clips will be deleted from the camera SDRAM. A software solution is available ("Camera control", as part of the SDK for PC, and "Plug'n Save" for Mac) which can monitor whether a camera is connected and will warn the user if activating the VfW driver will cause SDRAM contents to be deleted.

Table 2: Image modes supported

Sensor	Sensor Image Size	Resolution mode	Final Image Size	Max. no. of images stored in 16MBit memory (*Note 2*)	Max. no. of images stored in 64MBit memory (*Note 2*)	Approximate VfW framerate (*Note 1*)
VV6411	CIF 352 x 288	High	CIF 352 x 288	20	80	15 frames/sec.
		Low	QCIF 176 x 144 (Subsampled)	80	322 (see *Note 3*)	22.5 frames/sec.
VV6500	VGA 640 x 480	High	VGA 640 x 480	(6)	26	2 frames/sec.
		Low	QVGA 320 x 240 (Subsampled)	(26)	107 (see *Note 3*)	12 frames/sec.

Note: 1 VfW framerate is dependent on PC performance and USB bus loading

2 The number of images which can be stored is reduced if Audio sounds have been recorded on the camera or if custom sounds have been downloaded from the PC to the camera. The reduction of capacity depends on the length of audio clip, but a rough guide is that if 1 CIF image uses the same amount of SDRAM as 10sec of audio, and one VGA image uses the same amount of SDRAM as 30 sec. of audio.

3 A CIF camera with STV0681 and 64Mbit SDRAM can store up to 320 images by using QCIF mode. Where >99 images are still available, the LCD display will remain at 99. Where (no. of images available) <99, the LCD display will show the number of images available, as is the case with all other modes.

2.1.1 VV6411

VV6411 is a CIF resolution, 3.3V CMOS imaging sensor. A brief specification is shown in *Chapter 6*.

2.1.2 VV6500

VV6500 is a VGA resolution, 3.3V CMOS imaging sensor. A brief specification is shown in *Chapter 6*.

It is possible to make a PCB which can accept a VV6411 OR a VV6500 by putting the footprint for the VV6411 inside that of the vv6500.

2.1.3 IR filter

For IR filter design, the best choice filter follows the GS0034 dielectric stack filter specification, which is available from STMicroelectronics. An alternative, although not optimal filter, would be Schott S8612 doped glass also sold as CM500.

2.2 User interface

The user interface supported by STV0681 comprises of user controls, buzzer sounds or customised sounds and visual displays.

2.2.1 Push buttons

The following are the functions which are supported by the chipset. These functions are achievable with no more than 2 push buttons.

1 Mode button (Wake-up/Switch between modes)
This button allows the user (1.1) to wake the camera up from standby mode when the camera is to be used for taking pictures, or (1.2) to switch between modes of operation shown in *Chapter 3*.

2 Shutter button (Shutter/confirm action)
This button allows the user to take a picture or confirm an action, as shown in *Chapter 3*

The modes of operation are described in *Chapter 3*.

It may also be desirable to include an on-off slider switch. This has advantages and disadvantages, and its exact function is discussed further in the reference design available from ST.

Where a flashgun module is included in the camera, it will be necessary to include a flash on/flash off push button or slider switch, dependant on the exact flashgun module design. possible implementations are discussed in a separate application note AN1312 regarding flashgun implementation, available from ST.

2.2.2 LED indicator

An LED display camera status, i.e. to show that the camera is not in Standby/PC suspend mode.

2.2.3 Picture counter using 2 x 7 segment display

STV0681 stores a picture counter value, which shows how many images can still be captured. STV0681 supports a 2x7 segment LCD panel. In ‘Snapshot’ mode and continuous capture mode, this LCD panel displays the number of pictures still available, which is useful to identify when the user is approaching the maximum number of images which can be stored (see *Table 2*). It is possible to clear the images stored in memory, in order to continue taking pictures. In other modes, this LCD panel shows displays a 2-character code, which helps the user to navigate around the modes.

Note: A CIF camera with STV0681 and 64Mbit SDRAM can store up to 320 images by using QCIF mode. Where >99 images are still available, the LCD display will remain at 99. Where (no. of images available) <99, the LCD display will show the number of images available, as is the case with all other modes.

For suitable numeric LCD panel types, see *Section 4.7*.

2.2.4 Piezo buzzer

An on-chip Pulse Width Modulator (PWM) on STV0681 is used to generate buzzer sounds to signal certain events. The following are typical of the type of events which are indicated by the buzzer, and each has its own distinctive sound:

1 Camera has been 'Woken up' from standby mode (either by the user pressing a button, by re-connecting the power source, or by connecting a USB/RS232 connection).

2 Camera has been 'gone to sleep' i.e. moved into standby mode. Pictures are retained in memory.

3 Picture has been successfully taken after the user presses the capture button.

4 Picture has NOT been taken after the user presses the capture button. This indicates to the user that there is insufficient light, or that the exposure control was not ready due to a rapid change of lighting in the scene.

5 Picture has NOT been taken after the user presses the capture button, due to picture counter having reached the maximum number of images. The user has the chance to zero the counter if desired.

6 End of continuous capture in un-tethered 'Continuous' mode, due to memory full.

7 Self-timer activated and counting down.

2.2.5 Custom sounds

A camera which includes STV0681 and Audio playback hardware can have a set of custom sounds downloaded from a PC application. A different sound can be associated with each of the following functions:

Table 3: List of custom sound functions

Power On	Sound delete
Power Off	Continuous clip delete
Good picture	Clear memory
Bad picture (Normally due to insufficient light)	Confirm action
Memory full	Low power
Self timer #1	Flashgun ON
Self timer #2	Flashgun OFF
Low resolution	Flashgun Trigger
High resolution	Frequency 50kHz
Picture delete	Frequency 60kHz

Note: 1 Where a given function has a sound associated with it stored in SDRAM, the piezo buzzer does not give any beeps for that function. Not all functions need to have custom sounds associated with them, this is the choice of the user or OEM.

2 A demonstration PC application "CustomSounds" is available from ST, however this is not intended for end-users. Source code is available which allows the OEM to build their own PC application using the SDK.

2.3 Battery level detect and USB auto-switch

An on-chip battery level detector on STV0681 detects when the battery voltage falls below a threshold. The chosen threshold level is determined by a resistor values, as shown in *Chapter 6* Where no USB has been detected, the LCD display flashes, which indicates that the battery is low. Where a USB connection has been detected the LCD display does not flash.

Note: It may be a requirement of certain USB compliance tests that such additional hardware is included in the camera design, in order to enable the camera to switch to supply from USB and hence report back to the PC while connected to the USB bus without a battery.

2.4 Audio record and playback

2.4.1 Record

A camera which includes STV0681 and a microphone, comparator and other periphery (also utilizing the sensor pre-amplifier) can be used to record sounds which are stored in the same way as images. STV0681 will auto-detect the presence of Audio record hardware and include audio record and “delete last” functions into the user interface. The audio sample rate is 11.025kHz, and the signal is digitized using a successive approximation A-D converter with 8 bits resolution. The SDRAM stores 1 second of Audio recording per 11k Bytes of memory.

2.4.2 Playback

A camera which includes STV0681 and an amplifier, speaker/headphone socket, and other periphery, can be used to playback sounds which were either recorded on the camera or downloaded from the PC.

The quality of Audio playback is largely dependant on the type of speaker used, and on the correct mounting of the speaker in the camera plastics.

2.5 PC interface options and software support

Either USB Interface (full speed 12Mbit/sec. max.) or RS232 interface (115.2Kbaud) is supported by the chipset, with driver software available from ST for both. The interface type is auto-detected by the chipset. PC software can be one of the following:

1. Simple image upload demonstration software supplied by ST, allowing uploading of stills or 'continuous' images. This software should not be supplied as an end-user product.
2. TWAIN driver to suit all TWAIN compatible imaging applications
3. Video for Microsoft Windows™ driver for tethered video mode (USB only)
4. Custom end-user software developed by OEM using SDK (for SDK availability, contact ST). The SDK is supplied by ST as a 32-bit DLL format, running on Microsoft Windows™ 98, and accessed through a documented software interface. This provides the basis for developing a custom software application for uploading stills and/or video.

2.5.1 USB

Complete images (displayed as either thumbnails or in full resolution), or the entire SDRAM contents (e.g. for uploading continuously captured image sequences, recorded using 'Continuous Capture' mode) can be downloaded through USB, and USB connection also allows for tethered video mode to be activated by the USB driver.

Thumbnail image download is extremely fast for the entire memory contents in the camera. Once a picture is selected for download, full image download takes approximately 0.15 seconds per image for a CIF image (0.6 seconds for a VGA image), plus post processing time per image.

For USB interface details, see *Section 4.3*.

Note: Actual USB download and post processing time also depends on PC performance and USB bus loading

2.5.2 RS232

Thumbnails of images, complete stored images, or the entire SDRAM contents can be downloaded through RS232, but tethered video is not supported.

Once a picture is selected for download, full image download takes approximately 10 seconds per image for a CIF image (around 30 seconds for a VGA image), plus post processing time per image (of the order of 1 second approximately).

For RS232 interface details, see *Section 4.4*.

Note: Actual post processing time after RS232 download also depends on PC performance

2.6 Anti-flicker exposure and gain control

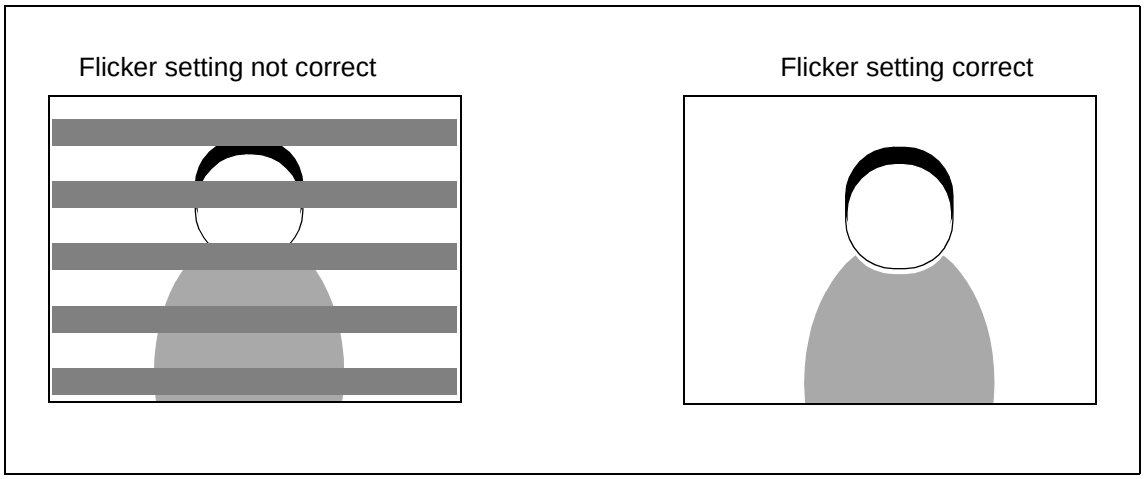
2.6.1 General

The chipset operates automatic exposure and gain control for either 50Hz or 60Hz mains-driven indoor lighting, using the same 12MHz crystal. This improves picture quality by selecting a set of exposure values which minimise ‘flicker’ effects. Detection of the mains frequency is dependant on the status of the GPIO3 pin, which can be achieved by population of a PCB link at a late stage in production, once the country of destination is known, without the need to change the crystal frequency.

The auto exposure and gain algorithm is always enabled during Snapshot’/self-timer/continuous mode. When the shutter button is pressed in ‘Snapshot’ mode, the chipset captures an image if the exposure and gain value has reached a suitable value for the current scene. If the light detected has suddenly changed, the camera may emit an audible tone to indicate that more time is required to reach the correct exposure target. In ‘Snapshot’ mode the chipset only captures the image data if sufficient light is present in the image. In continuous capture mode, the chipset captures images regardless of whether enough light is present.

The exposure control algorithm in STV0681 chooses exposure values which minimise “flicker” effects from occurring under fluorescent lighting. STV0681 can only prevent flicker in lighting powered by 50Hz or 60Hz electricity supply, but automatic detection of the flicker frequency is not possible. Hence choosing the correct anti-flicker setting is important, in order to prevent dark stripes form appearing across the image, and this selection must be done in hardware.

Figure 2: Illustration of flicker problem



2.6.2 Flashgun exposure

Where STV0681 and a flashgun module are included in the camera, and the flashgun enable signal is HIGH, the exposure mode will operate in a different manner. The CMOS sensor progressive scan readout requires that the sensor is set to maximum exposure so that all lines are being exposed at a certain point in time.

The “window” within which the flashgun needs to fire in order to correctly expose all sensor lines is of the order of a few 100µsec (contact ST for more precise details), therefore the flashgun module design should have reached maximum light output within this period after the falling edge of the flash trigger output from STV0681.

Possible flashgun implementations, regarding hardware interface, charge sensing, and flash energy required are discussed in a separate application note AN1312 regarding flashgun implementation, available from ST.

3 Camera modes of operation

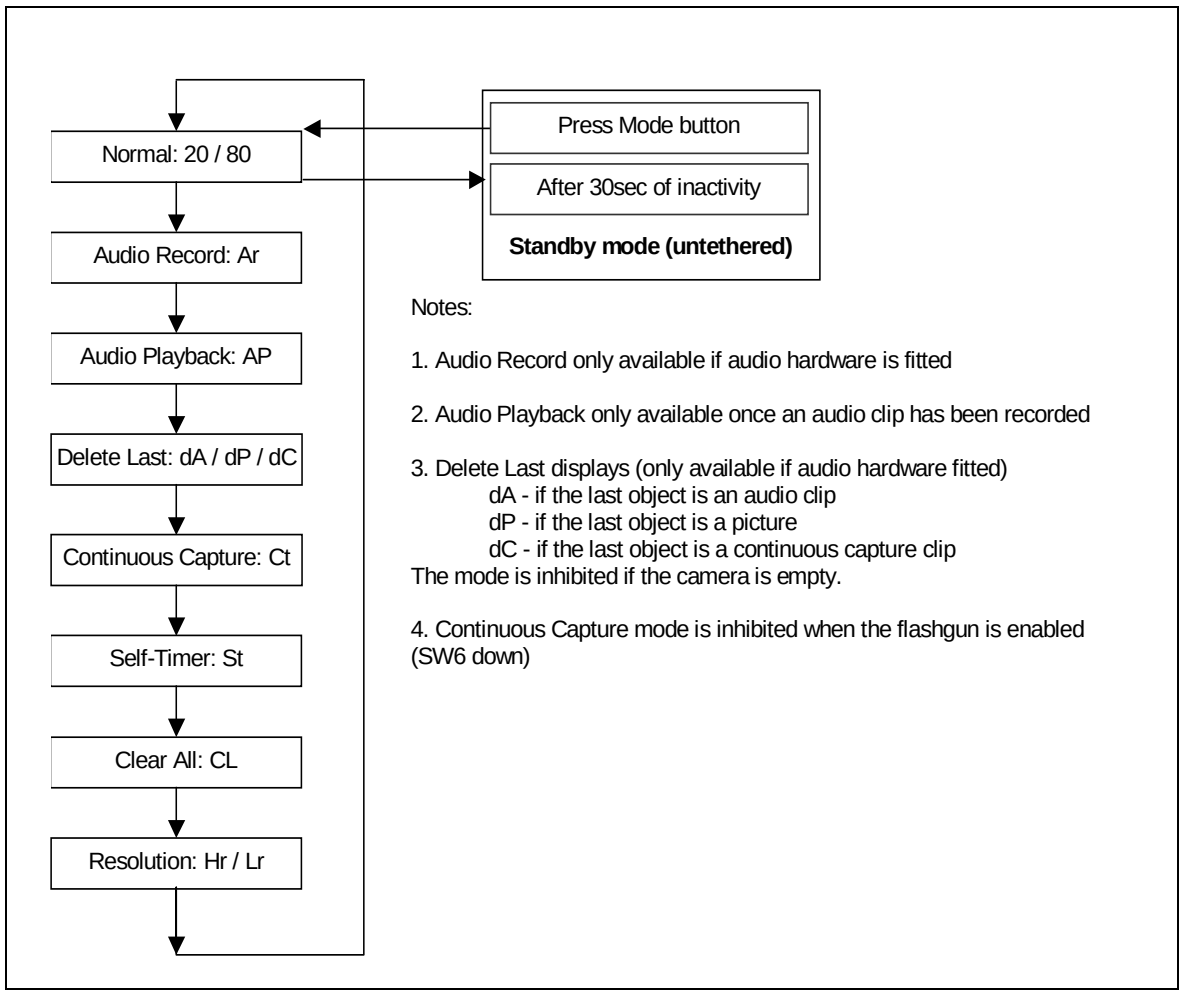
This section refers to the two switches as discussed in section *Section 2.2.1*

- “Mode”: connects GPIO0 pin of STV0681 to GND when pressed
- “Shutter”: connects GPIO1 pin of STV0681 to GND when pressed

Pressing the mode switch repeatedly cycles through a series of modes as displayed on the LCD. When a given mode is displayed it may be selected by pressing the shutter button. If an option is not selected within 5 seconds the display will revert to showing the number of available pictures.

3.1 Modes available

Figure 3: STV0681 modes (CIF camera with 16Mbit SDRAM assumed)



3.2 Description of modes

3.2.1 Standby mode (untethered) and Wake-up

On power-up, or wake-up from untethered standby mode, (i.e. by pressing the Mode button), the camera will beep twice. The LCD will briefly indicate the camera resolution either ‘Hr.’ for high resolution (80 CIF or 26 VGA images - using 64Mbit memory) or ‘Lr’ for low resolution (322 QCIF or 107 VGA images - using 64Mbit memory) and then display the number of pictures which may be taken. Please note that in Low Resolution Mode, although there can be up to 322 images available, the LCD counter will only go up to 99, it will continue reporting 99 until there are less than 99 images left.

The camera will go back to standby mode either after 30 seconds of inactivity, LED1 will turn off and the LCD will go blank. This can also be done by pressing the mode switch for more than 2 seconds.

3.2.2 Normal mode

Pressing the shutter button will take a picture. The camera will beep. A high pitched beep indicates that the picture was taken successfully and the counter will decrement (if there are less than 99 images left to take). A low beep indicates insufficient light to take a picture. A series of beeps indicates that the camera is full.

Stored pictures may be uploaded to a PC at any time, whether or not the camera is full. Plugging the USB connector into the camera will cause it to reset and issue a double beep but all stored pictures will remain. When the USB connector is unplugged the camera will go to sleep. When connected to the PC the camera may still be used in the normal way.

Note: With the flashgun enabled the camera will always take a picture, whether or not there is sufficient light.

3.2.3 Audio record - Ar

This mode is available with audio record hardware fitted.

Pressing the shutter button within 5 seconds will cause the camera to start recording for as long as the shutter button is pressed down. If the shutter button is not pressed within 5 seconds the camera will revert to normal picture taking mode. Whilst recording, the LCD display flashes ‘Ar’. If the recording stops because the memory is full, the ‘memory full’ audio tone is sounded and the display will stop flashing and display ‘00’. The audio data is digitized and stored in SDRAM.

3.2.4 Audio Playback - AP

This mode is available with audio playback hardware fitted.

Pressing the shutter button within 5 seconds will cause the camera to play back the most recent audio recording. If the shutter button is not pressed within 5 seconds the camera will revert to normal picture taking mode. Whilst playing, the LCD display flashes ‘AP’.

Once in Audio Playback mode, repeated presses of the shutter button will step the camera through each of the audio recordings in the camera (most recent first). Keeping the shutter button pressed down will also cycle through the audio recordings. Pressing the mode button during playback will stop the audio clip.

Note: Minimum audio recording length is set to 0.5 seconds.

3.2.5 Delete Last Object - dA/dP/dC

This mode is available with audio record hardware fitted.

If the last object captured was an audio recording ’dA’ (delete audio) will be displayed, if the last object was an image, then ’dP’ (delete picture) will be displayed, or, if the last object was part of a continuous capture sequence, then ’dC’ (delete continuous) will be displayed. If the camera is empty, the mode will be suppressed. The mode works in the same way as ‘CL’ (Clear All), i.e. once the mode is selected, pressing the shutter button once will cause the camera to beep and ‘dA’, ‘dP’ or ‘dC’ to start flashing. Pressing the shutter button again within 5 seconds will delete the last audio clip, picture or continuous capture sequence.

3.2.6 Continuous mode - Ct

Pressing the shutter button within 5 seconds will cause the camera to start taking pictures for as long as the shutter button is pressed down (and the camera is not full). If the shutter button is not pressed within 5 seconds the camera will revert to normal picture taking mode.

Note: 1 During continuous mode the camera will allow pictures to be taken regardless of the available light, which could result in insufficient exposure.

2 In continuous mode, only every alternate field is grabbed hence capture rate is halved. E.g. 12.5fps CIF and 7.5fps VGA

3 Continuous Mode is suppressed when the FlashGun enable signal (GPIO2) is high.

3.2.7 Self timer - St

Pressing the shutter button will now start a 10-second self-timer. The camera will issue a short beep every second and then a longer beep. A further beep will then indicate that the picture has been taken (high beep - picture successful, low beep - insufficient light, picture not taken). The self-timer mode can not be selected when the camera is full. The self-timer countdown cannot be stopped once it has started.

3.2.8 Clearing the camera memory - CL

Pressing the shutter button once will cause the camera to beep and the ‘CL’ to start flashing. Pressing the shutter button again within 5 seconds will clear all the images/audio clips in the camera and reset the counter.

3.2.9 Changing picture resolution - Hr/Lr

The resolution option is displayed, either Hr to change to high-resolution mode (if currently in low-resolution mode) or Lr to change to low-resolution (if currently in high-resolution mode). Press the shutter button within 5 seconds of selecting the resolution option, the camera will beep and the display will reset indicating the number of pictures available in the new mode. The picture resolution can be changed at any time, i.e. the camera can store both high and low resolution images.

4 STV0681 hardware interfaces

4.1 Sensor interface

STV0681 uses a standard ST digital interface from the sensor, and the sensor clock input is provided by an output from STV0681. The design of a camera using this chipset should be implemented as closely as possible to the reference design (*Chapter 6*), in which case the chipset can be regarded as a functional ‘black box’, and no further details regarding the STV0681-sensor interface are required.

4.2 Memory interface

STV0681 is designed to interface to an external 16Mbit or 64Mbit SDRAM (see *Table 2*). The SDRAM device must have a 16 bit wide data bus and operate from a 3.3V supply. Two sizes of SDRAM memory are supported by STV0681, 16MBits (1M x 16 bits wide) or 64MBits (4M x 16 bits wide), the memory size is auto-detected by STV0681. STV0681 clocks the SDRAM at 6MHz, typically this is well below the figures offered by most manufacturers’ devices.

4.2.1 SDRAM current consumption

For maximum system battery life while no pictures are being taken, and to assist in meeting requirements for USB compliance, an SDRAM should be chosen with the lowest possible self refresh current specification.

In addition, the USB suspend mode current specification requires that the camera will consume no greater than 300µA when un-tethered. Meeting this specification, which is included in the requirements for USB compliance, assumes an SDRAM with up to approximately 250µA self-refresh current, based on a current consumption of approximately 50µA for STV0681 + support circuit.

4.2.2 SDRAM interface timing requirements

Figure 4: SDRAM Read Timing (16Mbit device, burst read)

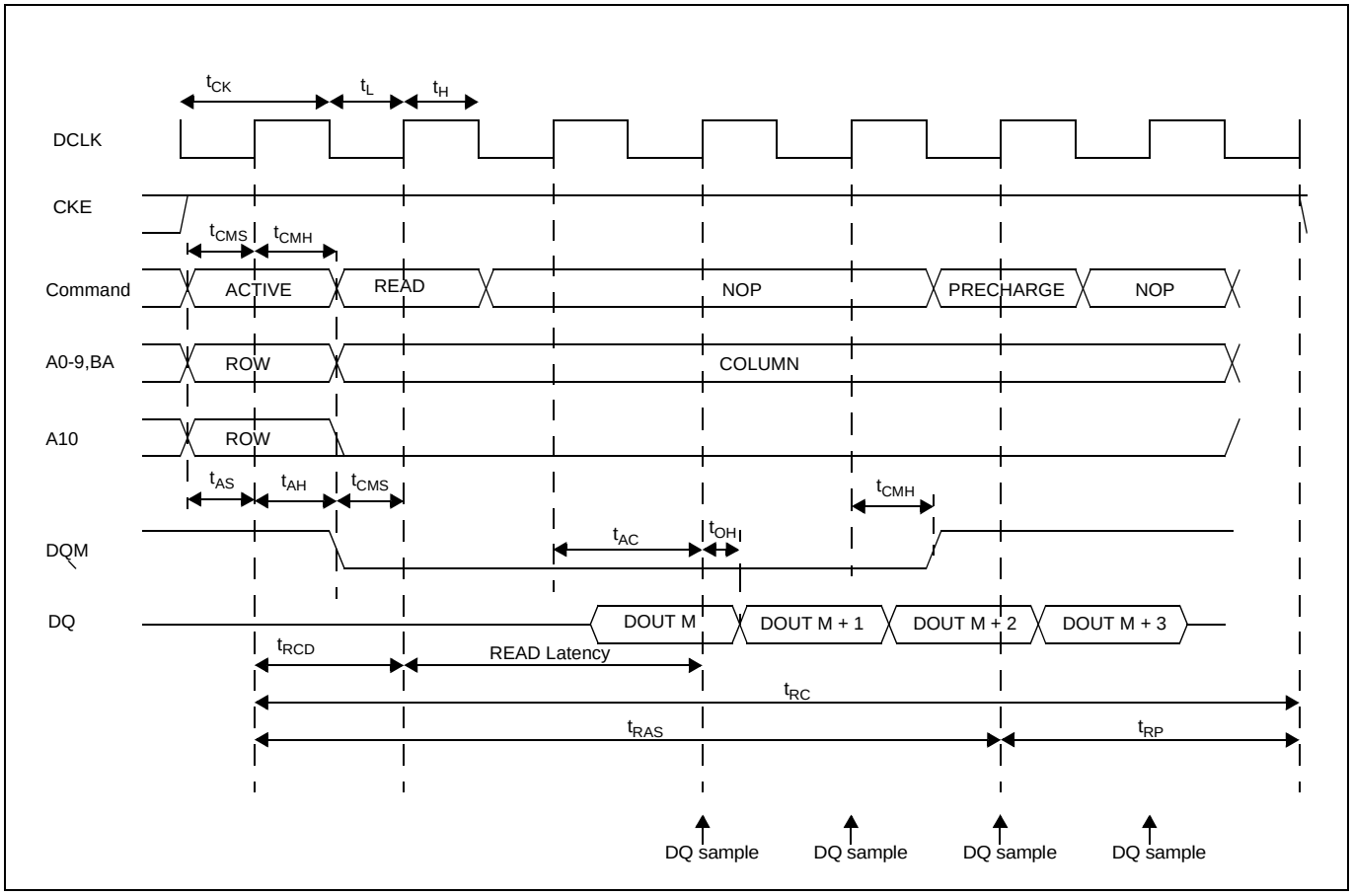


Figure 5: SDRAM Write Timing (16Mbit device, burst write)

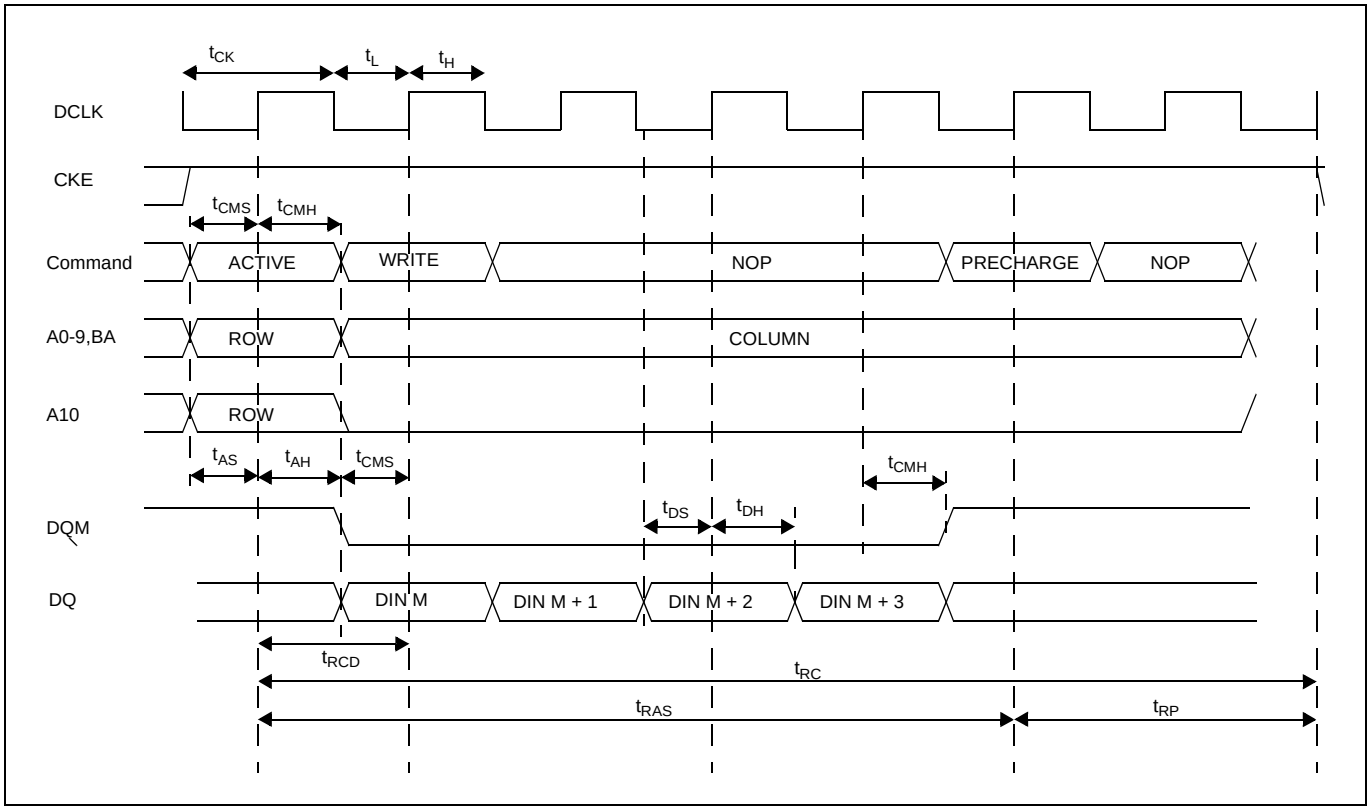


Table 4: Timing parameters for SDRAM read/write

Symbol	Min.	Max	Units
t_{CK}	166.45	166.89	ns
t_{CH}	½		t_{CK}
t_{CL}	½		t_{CK}
t_{AC}		½	t_{CK}
t_{OH}	0		ns
t_{CMS}	82.88		ns
t_{CMH}	82.85		ns
t_{AS}	82.88		ns

Symbol	Min.	Max	Units
t_{DS}	81.01		ns
t_{DH}	83.41		ns
t_{RCD}	1		t_{CK}
t_{RAS}	5	5	t_{CK}
t_{RC}	7		t_{CK}
t_{RP}	2		t_{CK}
t_{RCD}	1		t_{CK}
t_{AH}	82.76		ns

4.2.3 SDRAM refresh period

The SDRAM refresh period from STV0681 is guaranteed to be no greater than 15.6µS during ‘Snapshot’/self-timer/continuous/tethered video modes of operation (i.e. not standby mode). In standby mode, the SDRAM is set to self-refresh, therefore no refresh from STV0681 takes place.

4.2.4 SDRAM initialisation period

The SDRAM initialisation period is currently set to 981µS in STV0681.

4.3 USB interface

STV0681 includes a USB Version 1.1 compliant Universal Serial Bus Interface, including a transceiver. This allows direct connection from STV0681 to a USB connector with minimal additional hardware (i.e. a small number of passive discretes) - see *Chapter 6*

The USB interface interfaces the STV0681 to the USB at full speed 12MHz data rate. Some of the features are:

- Compliant with USB protocol revision 1.1.
- USB protocol handling.
- USB device state handling.
- Clock and data recovery from USB.
- Bit stripping and bit stuffing functions.
- CRC5 checking, CRC16 generation and checking.
- Serial to parallel conversion.
- Single bulk end point.

USB drivers are supplied by ST. For USB timing information, please refer to the USB specification V1.1.

4.4 UART module for RS232 interface

The UART module on STV0681 provides a 115200 baud full duplex serial interface to an external host.

4.4.1 RS232 physical interface

STV0681 does not support direct connection to an RS232 serial link. Physical line driver circuitry is required, e.g. using a standard RS232 transceiver chip, or by using a small number of low cost discretes (refer to Reference Design for details). Unscreened cable can be used, a suitable low cost connector is a 3.5mm stereo audio jack plug.

4.4.2 UART module overview

Receiving data

The UART module in STV0681 receives serial data through the RXD pin. Data reception is initiated by a 1-to-0 transition on RXD, and the received data is sampled every 8.66µS.

If the RXD input is not 0 when the incoming data is first sampled, the UART module goes back to look for another 1-to-0 transition. This is to provide rejection of false start bits. If the start bit proves valid, reception of the rest of the frame will proceed.

Transmitting data

When a transmission is activated by STV0681, the contents of an internal transmit shift register are shifted onto the TXD pin, every 8.66µS.

The UART operates at 12MHz, which is not an integer multiple of 115200, so the actual baud rate is 115232 +/- 0.3%, which is well within the requirements of a typical 16x oversampling UART, which can tolerate a 3.75% error in baud rate.

4.5 Power management and battery type

STV0681 and the SDRAM require a 3.3V supply. Where a VV6411 or VV6500 (3.3v) sensor is used, a single voltage regulator can be used to regulate the supply for all three components from the battery, or the sensor on-board VReg can be used. These are explained more fully in the reference design.

4.5.1 Power switching to USB

Included in the USB compliance requirements, is the ability of the camera to report to the PC when connected to the USB bus, **whether or not** there is a fresh battery in the camera. This means that power sourcing from USB is required, which also saves on battery life while the camera is used in USB tethered video mode. In order to allow switching from battery to USB power, some additional hardware is required.

- The USBDETECT input to STV0681 is used to detect that a USB power supply is connected
- If the USB is detected, additional hardware is used to switch off the battery
- An inrush protection circuit can protect the USB bus from current draw in the case of a low battery/battery not fitted. This may be necessary to comply with the USB specification.

For precise USB compliance requirements, please consult the USB specification version 1.1

4.5.2 Switched sensor supply

Dependant on the hardware implementation, the SENSPWR output from STV0681 can be used to put the sensor into Suspend mode. This has a significant improvement on battery life.

4.5.3 Battery type

This is hardware dependant. The schematics referred to in *Chapter 6* assume either three or four 1.5V cells.

4.6 Quartz crystal

Regardless of the sensor type or anti-flicker requirements, the sensor + STV0681 chipset operates from a single 12MHz fundamental quartz crystal. For specification requirements, see *Table 14*. STV0681 includes an on-chip low jitter PLL, for PLL characteristics, see *Table 13*.

4.7 Numeric LCD interface

STV0681 supports a 2-digit LCD panel only, for alpha-numeric display.

4.7.1 LCD types

STV0681 connects to a non multiplexed, direct drive LCD with 2 x 7 segments. Many LCD types are compatible with this interface. The LCD refresh frequency is 34.7Hz.

4.7.2 LCD interface pinout

The convention for segment numbering is as follows: ’0’ connects to segment ’a’, ’1’ connects to segment ’b’, and so on, where a to g are standard for all 7-segment displays, as well as an LCD common output, giving fifteen signals in total.

4.8 Switches and LED's

The GPIO lines on STV0681 have pre-defined functions as follows, see *Section 2.2* for user interface functionality,

MODE push button and SHUTTER push button: GPIO0 and GPIO1

Both push button inputs have internal de-bounce circuits, reducing the amount of hardware required externally. It is recommended that labelling is used on the camera casing to help the user understand the functioning of the 2-button interface.

4.8.1 Input to select between 50 and 60Hz flicker frequency: GPIO3

This allows for factory setting of the anti-flicker frequency, dependant on the final country of destination. See also *Section 2.6*. The polarity of this selection is detailed in the reference design.

4.8.2 LED indicator output: GPIO5

The LED output has an 8mA current sinking capability.

4.8.3 Other pins: GPIO2, 4, 6, 7

With STV0681, these pins are used, as detailed in *Table 5*.

Table 5: Other GPIO usage with STV0681

GPIO	2	4	6	7
Audio Record	No	Yes	No	No
Audio Playback	No	No	Yes	No
Flashgun	Yes	No	No	Yes

Their specific functions are detailed in the reference design and in the following documents available from ST:

- Audio: Application note AN1310
- Flashgun: Application note AN1312

4.8.4 Audio Record Hardware interface

STV0681 implements a successive approximation A/D conversion by outputting successive analogue levels through the DAC output, which are compared with the actual signal level (output from the sensor microphone preamplifier), and the resultant high or low signal from the comparator is read at GPIO4. The sampling frequency is 11kHz, and the successive approximation is done at 8 bits resolution per sample. It is not possible to speed up the sampling frequency due to the limitation of STV0681 processing speed.

An actual hardware implementation is given in the audio application note AN1310.

4.8.5 Audio Playback Hardware interface

STV0681 outputs the desired signal level through the DAC output, which is amplified to the speaker or headphone socket. GPIO6 is used to switch off the amplifier during periods of audio recording, to prevent the successive approximation waveform from being heard during periods of recording, and to reduce the power consumption and unwanted crackle through the speaker.

An actual hardware implementation is given in the audio application note AN1310.

4.9 Flashgun hardware interface

STV0681 will revert to flashgun exposure when it detects GPIO2 is high. Ideally the hardware should combine the two factors of (a) user intention (e.g. user switches on flashgun) and (b) charge sensing (i.e. flash is charged up and ready to fire).

These two factors (a) and (b) are independent, since there may be a delay of several seconds between switching on the flashgun charger, and the flashgun being able to fire. To revert to flashgun exposure before the flashgun is completely charged up would cause very bad pictures to be taken in low light conditions because there is no “low light” threshold when flashgun exposure is enabled, since the camera expects a flash to fire. A suggested flashgun hardware interface is given in the flashgun application note AN1312.

When flashgun exposure is enabled and the shutter button is pressed, a picture will be taken and the flash trigger pin GPIO7 will be pulsed low at the correct point in time so that all lines of the CMOS imager are exposed.

4.10 IR filter

An Infra-Red Blocking Filter is required to achieve correct colour response. The exact specification for the IR filter characteristics are given in the reference design manual.

5 Software support

5.1 General features

The chipset is a dual-mode camera, i.e. stills and video, and is supported by a range of demonstration software, standard drivers, and software development options.

Driver software is available to support both USB and RS232 interface including standard TWAIN and video for Microsoft Windows™ drivers (VfW through USB only) for Win98/Win2k/WinME. Quicktime drivers and a Photoshop stills plug in for MacOS 8.6/9.0/9.1 are also supported.

Example software applications (PC only) are provided to create .AVI video files from untethered continuous capture of images (AVICreator), to upload still images and recorded sounds (LCDCdemo) and to download .WAV files from the PC to the camera (CustomSound). In each case, PC source code is provided to assist in OEM software development using the SDK.

ST colour processing and defect detection/correction software runs on the host and is supplied under licence agreement, as part of all host software/drivers/SDK.

5.1.1 *Still image* upload

This is available through demonstration software, OEM custom software, or using standard TWAIN applications. Features include:

- Fast upload through USB, or upload through RS232.
- Colour display of image thumbnails for picture selection.
- Download of full image once selected by user software.
- Automatic detection and correction of sensor defects
- Colour processing of full image, using the ST colour process

The above features also apply to “AVI Creator” or any OEM custom software for AVI video creation from pictures taken while un-tethered, since this is essentially a “stills” function.

5.1.2 *Streaming video* (only while tethered to USB)

This is available through demonstration software, or using standard VfW applications. Features include:

- Streaming video through standard VfW driver
- Automatic detection and correction of sensor defects
- Colour processing of full image, using the ST colour process

5.2 Software installation

The following software support is only available to OEMs. Access to the latest installation files is possible through a password-protected web page, contact ST for details. The install file gives the option to install:

- Drivers (always check web site for latest driver version).
- EVK software, i.e. LCDCdemo.exe and AVIcreator.exe, G2Video.exe, and CTItest2.exe
- SDK installation: source code for sample applications, and documentation

5.2.1 Driver support available

Table 6: Driver choices

Interface type:	RS232	USB
PC Operating system	Microsoft Windows™: Win9x, WinNT4, Win2k, Windows Millennium	Microsoft Windows™: Win98 and Win2k only, Windows millenium
Mac OS	N/A	8.6, 9.0, 9.1

5.2.2 EVK software

Note: The following is also supplied with evaluation kits/demonstration units, but all the following software is only for demonstration purposes and should NOT be supplied as an end-user product. However, application-level source code (i.e. not driver/colour processing source) for LCDCdemo.exe, AVI creator, and CTItest.exe is available as part of the SDK, which allows similar applications to be built by the software developer:

1. Simple demonstration software **LCDCdemo.exe** for uploading thumbnails and images.
2. **AVIcreator.exe** software for uploading continuous images for creating ‘movie’ clips.
3. **G2Video.exe** is a VfW application which shows streaming video while tethered to USB and allows creation of.AVI video clips.
4. **CTItest.exe** is only for debugging purposes, for software developers using the SDK

5.2.3 Software Development Kit (SDK) and source code

A software development kit allows the OEM to develop a custom application which calls the same range of drivers as listed in *Section 5.2.1*, hence allowing the OEM application to perform picture download, thumbnail display, and colour processing using the ST colour process. Inclusion of source code for the applications listed in *Section 5.2.2* allows the software developer to use these as the basis for their own application.

The SDK is supplied by ST as a 32-bit DLL format, running on Microsoft Windows 98/Win2K™, and accessed through a documented software interface. Development requires Microsoft Visual Studio Ver. 6 or later. This provides the basis for developing a custom software application for stills.

Note: Source code for PC Drivers, Defect Correction, and Colour Processing algorithms are not available.

6 Detailed chipset specifications

6.1 Typical camera specifications

The following data assumes that the camera has been built according to the ST Reference Design.

Dual USB or battery power supply is only possible when the required power switching hardware is included.

Figures are approximate and depend on actual components sources.

Table 7: Typical camera specifications

Supply Voltage	4.1-6V (when powered from battery or USB)
Operating Temperature range	0^oC - 40^oC
Max. RS232 cable length supported	2m
CIF output	352 x 288 pixels
QCIF output	176 x 144 pixels
VGA output (using VV6500)	640 x 480 pixels
QVGA output (using VV6500)	320 x 240 pixels
SDRAM storage and image upload format	Raw Bayer
PC driver output format	Colour RGB bitmap

Table 8: Approximate shutter speeds

Sensor	Min.	Max
VV6411	8.67µS	44mS
VV6500	7.94µS	66mS

6.2 STV0681 companion processor

Table 9: STV0681 specifications

Parameter	Min.	Typ.	Max.	Units
Supply voltage	3.0	3.3	3.6	V
Current consumption (normal operation)		18	-	mA
Stand-by current consumption	-	10	-	µA
Package	100TQFP (14x14x1.4)			
Exposure control	1 000 000 : 1			

Table 10: STV0681 absolute maximum ratings

Parameter	Range	Units
Ambient temperature	0 to 40	°C
Storage temperature	-50 to 150	°C
Voltage on USB D+/D-	0-VDD	V

Table 11: STV0681 USB specifications

Parameter	Description	Min.	Typ	Max	Units	Notes
VDD	Power Supply	3.0	3.3	3.6	V	
V_{ILU}	USB differential pad D+/D- input low			0.8	V	
V_{IHU}	USB differential pad D+/D- input high (driven)	2.0			V	
V_{IHUZ}	USB differential pad D+/D- input high (floating)	2.7		3.6	V	
V_{DI}	USB differential pad D+/D- input sensitivity	0.2			V	1
V_{CM}	USB differential pad D+/D- common mode voltage	0.8		2.5	V	2
V_{OLU}	USB differential pad D+/D- output low voltage	0.0		0.3	V	
V_{OHU}	USB differential pad D+/D- output high voltage	2.8		3.6	V	
V_{CRS}	USB differential pad D+/D- output signal cross over voltage	1.51		1.79	V	
R_{PU}	USB differential pad D+/D- pull up resistor	1.425		1.575	kΩ	
R_{PD}	USB differential pad D+/D- pull-down resistor	14.25		15.75	kΩ	
TF_R	Rise Time	4		20	ns	
TF_F	Fall Time	4		20	ns	
TF_{RFM}	Differential Rise Time and Fall Time Matching	96		98	%	*Note 3*
Z_{DRV}	Driver Output Resistance	24.7	26.6	30.0	Ω	*Note 4*

Note: 1 V_{DI} = |(D+) - (D-)|

2 V_{CM} includes V_{DI} range.

3 TF_{RFM} =(TF_R / TF_F).

4 Z_{DRV} includes an external resistor of 20 Ohms serial to this transceiver.

Table 12: STV0681 DC characteristics

Parameter	Description	Min.	Typ	Max	Units	Notes
V_{IL}	CMOS input low voltage			0.35 VDD	V	
V_{IH}	CMOS input high voltage	0.65 VDD			V	
V_{T+}	CMOS schmitt input low to high threshold voltage		2.15		V	
V_{T-}	CMOS schmitt input high to low threshold voltage		1.05		V	
V_T	Threshold point		1.65		V	
V_{OH}	Output high voltage	2.4			V	
V_{OL}	Output low voltage			0.4	V	

Table 13: STV0681 PLL characteristics

Parameter	Conditions	Symbol	Min.	Typ	Max	Unit
Peak to peak jitters	@VCOfreq = 240MHz - 312MHz	--	--	--	500	ps
Duty cycle		--	45	50	55	%
Operating voltage range		VDD	3	3.3	3.6	V
Input low voltage	VDD=3.3V	VIL	-		0.8	V
Input high voltage	VDD=3.3V	VIH	0.7VDD		VDD	V
Pull in Time + Locking Time		Ready	--	--	0.1	ms
Output Slew Rate	CL: Output Load (pF)	Tsr(Fout)	--	0.100+0.1082*CL	--	ns

Table 14: STV0681 crystal tolerance

Parameter	Min.	Typ	Max	Units
Crystal specification	50/50/10/30 (12mhz Fundamental)			
Crystal frequency		12.000		MHz
Frequency tolerance			50	ppm
Temperature stability			50	ppm
Operating temperature	-10			Deg. C

6.3 VV6411 and VV6500 sensors

Table 15: VV6411 specifications

Colour Image Format	352 x 288 pixels (CIF)			
Pixel Size	7.5 x 6.9µm			
Image array size	2.67mm x 2.04mm			
Array Format	CIF			
Sensor signal / Noise ratio	Approx. 57dB			
Package type	36LCC			
Supply Voltage	3.3V DC +/-5%			
Operating Temp. range	0^oC - 40^oC			
Current consumption	**Min.**	**Typ**	**Max.**	**Units**
'Snapshot'/self-timer/continuous/tethered video modes of operation		25	40	mA
Stand-by Mode/PC Suspend Mode		<70	100	µA

Table 16: VV6500 specifications

Colour Image Format	640 x 480 pixels (VGA)			
Pixel Size	7.5 x 7.5µm			
Image array size	4.89mm x 3.66mm			
Array Format	VGA			
Sensor signal / Noise ratio	Approx. 57dB			
Supply Voltage	3.3V DC +/-5%			
Package type	48LCC			
Operating Temp. range	0^oC - 40^oC			
Current consumption	**Min.**	**Typ**	**Max**	**Units**
'Snapshot'/self-timer/continuous/tethered video modes of operation		30	50	mA
Standby Mode/PC Suspend Mode, SUSPEND pin asserted (see *Note 1*)		<100	150	µA
Standby Mode/PC Suspend Mode, SUSPEND pin *not* asserted (see *Note 2*)		<200	200	µA

Note: 1 Assuming appropriate external hardware recommendations are implemented, the sensor SUSPEND pin is asserted during Standby Mode/PC Suspend Mode. Hence the sensor is placed in Sensor Suspend mode by means of (a) a Serial interface message and (b) the SUSPEND pin being asserted.

2 Where the external hardware does not permit the sensor SUSPEND pin to be asserted (during Standby Mode/PC Suspend Mode, the sensor is placed in Sensor Suspend mode by means of a Serial interface message only. This increases current consumption due to a pull-up on the SUSPEND pin. This only applies to VV6500.

6.4 Typical current consumption of complete camera

The following data assumes that the camera has been built according to reference design referred to in *Chapter 13*. Figures are approximate and depend on actual components sources - see notes.

The sensor operates at @ 3.3V DC

Table 17: Current consumption, complete STV0681+VV6411/6500 camera

Mode	Typical	Comments
'Snapshot'/Continuous/ Self timer mode (while un-tethered)	60mA	Assuming appropriate hardware included, power is sourced from PC while USB connected.
'Snapshot'/Continuous/ Self timer mode (while tethered to PC)	60mA	
While playing back audio sounds through speaker	90mA	Assuming 8Ω speaker as explained in application note AN1310
Standby mode (when NOT connected to USB): Sensor SUSPEND pin asserted (see *Note 3*)	Approx. 270µA + SDRAM self-refresh current (see *Note 2*) + sensor suspend mode current (see *Note*)	Total current in this mode equals: STV0681 Standby current consumption (see *Note 1*) + SDRAM self-refresh current (see *Note 2*) + peripheral circuitry (approx. 50µA). + Sensor suspend mode current (See *Note*)
PC Suspend mode (when connected to USB): Sensor SUSPEND pin asserted (see *Note 3*)	Approx. 300µA + SDRAM self-refresh current (see *Note 2*) + sensor suspend mode current (see *Note*)	Total current in this mode equals: STV0681 Standby current consumption (see *Note 1*) +SDRAM self-refresh current (see *Note 2*) + peripheral circuitry (approx. 50µA). + 200µA, based on 1.5k pull-up in camera and 15k pull-down in PC. + Sensor suspend mode current (See *Note*)
Standby mode (when not connected to USB): sensor powered off using FET (see *Note 4*)	Approx. 270µA + SDRAM self-refresh current (see *Note 2*)	Total current in this mode equals: STV0681 Standby current consumption (see *Note 1*) +SDRAM self-refresh current (see *Note 2*) + peripheral circuitry (approx. 50µA).
PC Suspend mode (when connected to USB): sensor powered off using FET (see *Note 4*)	Approx. 100µA + SDRAM self-refresh current (see *Note 2*)	Total current in this mode equals: STV0681 Standby current consumption (see *Note 1*) +SDRAM self-refresh current (see *Note 2*) + peripheral circuitry (approx. 50µA).

Note: 1 See Table 9 from Section 6.2

2 From limited evaluation, typical self-refresh current figures of certain SDRAM chips are well below manufacturers' maximum specification, e.g. 100-250µA.

For Sensor suspend mode current, see Table 15 and Table 16.

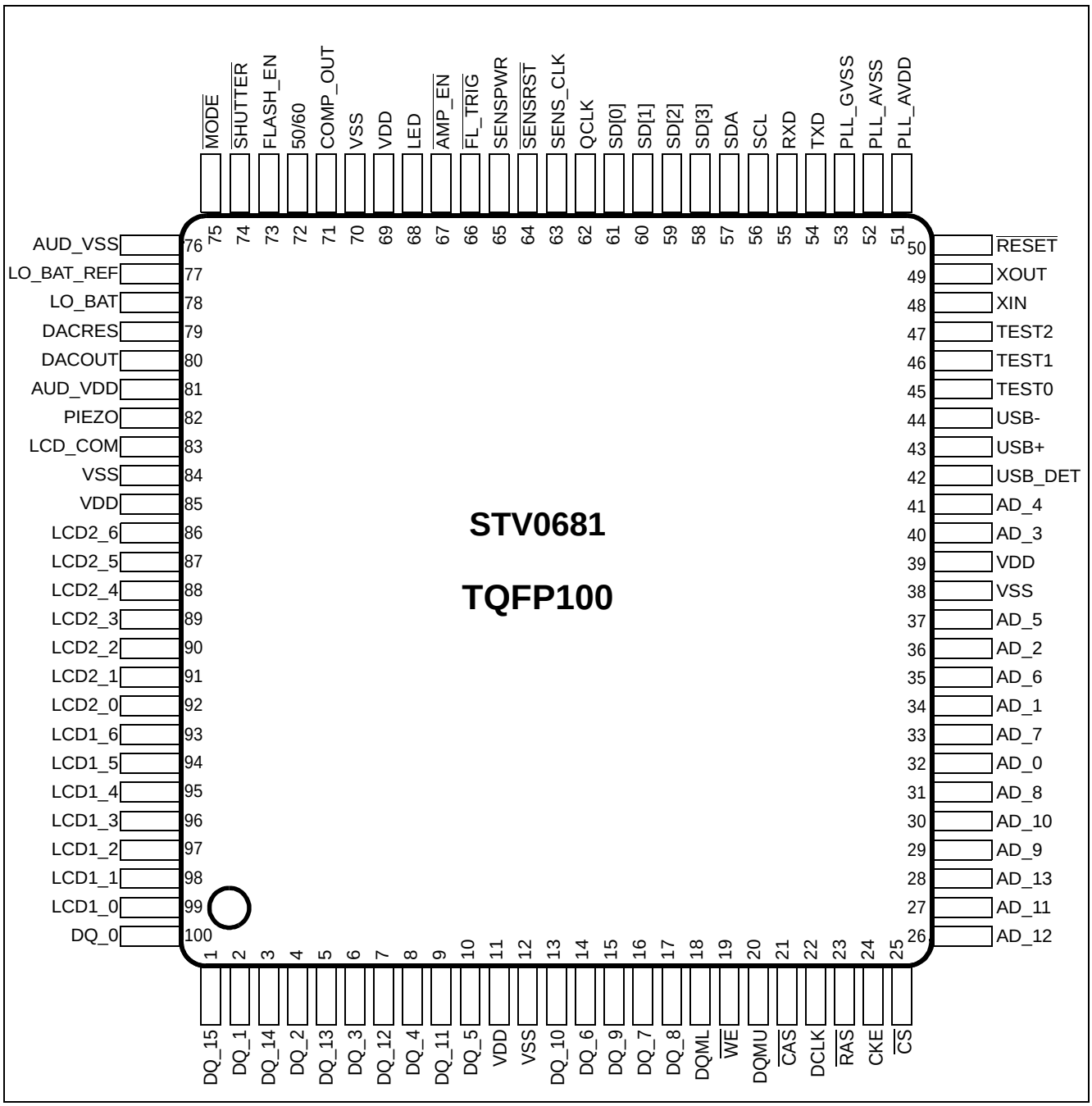
3 If the appropriate hardware to assert the sensor SUSPEND pin is not fitted, an additional current consumption in Standby/PC Suspend mode of Approx. 50µA can be expected with VV6500.

4 Option included in reference design to save current consumption, which can increase battery life and increase chances of meeting USB suspend mode compliance requirements.

7 STV0681 pin description

7.1 STV0681 pinout

Figure 6: STV0681 pinout diagram



7.2 STV0681 pin description

Table 18: STV0681 pin listing

Pin no.	Signal	Type	Description	drive
Sensor Interface				
65	SENSPWR	Output, active high	Power-up Sensor	2mA (SL)
64	SENSRST	Output, active low	Reset Sensor	2mA (SL)
56	SCL	Input/Output (OD,T)	Sensor serial interface	4mA (SL)
57	SDA	Input/Output (OD,T)	Sensor serial interface	4mA (SL)
58	SD[3]	Input (S,T)	Sensor data	
59	SD[2]	Input (S,T)	Sensor data	
60	SD[1]	Input (S,T)	Sensor data	
61	SD[0]	Input (S,T)	Sensor data	
62	QCLK	Input (S,T)	Qualification clock from sensor	
63	SENS_CLK	Output	Clock output to sensor	4mA
I/O and Camera Control pins				
75	MODE	Debounced input	Push button (Wake-up/Mode)	
74	SHUTTER	Debounced input	Push button (Shutter/Confirm)	
73	FLASH_EN	Input	Enable Flash Exposure (Active High)	
72	50/60_SEL	Input	S elect between 50Hz and 60Hz lighting	
71	COMP_OUT	Input	Output from Audio Comparator	
68	LED	Output (OD)	LED indicator	8mA (SL)
67	AMP_ENABLE	Output, active low (OD)	Audio Amplifier Enable	8mA (SL)
66	FL_TRIG	Output, active low (OD)	Flashgun trigger	8mA (SL)
USB Interface				
42	USBDET	Input (S)	Detect Power source from USB. (For camera with RS232 only, this pin should be tied to GND)	USB specification V1.1 compliant I/O
43	DATA+	Input/Output	USB bus (For camera with RS232 only, this pin should be connected to test points to allow for USB production test (lens focussing))	
44	DATA-	Input/Output	USB bus. (For camera with RS232 only, this pin should be connected to test points to allow for USB production test (lens focussing))	

Table 18: STV0681 pin listing

Pin no.	Signal	Type	Description	drive
RS232 Interface				
54	TXD	Output	Serial data transmit (For camera with USB only, this pin should be tied to RXD)	4mA (SL)
55	RXD	Input (S)	Serial data receive (For camera with USB only, this pin should be tied to TXD)	
STV0680B Master Clocks and Reset				
48	XIN	Input	Quartz Crystal IN	
49	XOUT	Output	Quartz Crystal OUT	
50	RESET	Input (S)	Active (LOW) STV0680B reset	
System Memory (SDRAM) Interface				
20	DQMU	Output	Data input/output mask for dram_DQ[15:8]	2mA (SL)
22	DCLK	Output	Clock: all SDRAM input signals are sampled on the positive edge	4mA (SL)
24	CKE	Output	Clock enable: activates (HIGH) and deactivates (LOW) the SDRAM CLK signal	2mA (SL)
32	AD0	Output	SDRAM address A0	2mA (SL)
34	AD1	Output	SDRAM address A1	2mA (SL)
36	AD2	Output	SDRAM address A2	2mA (SL)
40	AD3	Output	SDRAM address A3	2mA (SL)
41	AD4	Output	SDRAM address A4	2mA (SL)
37	AD5	Output	SDRAM address A5	2mA (SL)
35	AD6	Output	SDRAM address A6	2mA (SL)
33	AD7	Output	SDRAM address A7	2mA (SL)
31	AD8	Output	SDRAM address A8	2mA (SL)
29	AD9	Output	SDRAM address A9	2mA (SL)
30	AD10	Output	SDRAM address A10	2mA (SL)
27	AD11	Output	SDRAM address A11 for 64M SDRAM or BA for 16M SDRAM	2mA (SL)
26	AD12	Output	SDRAM address A12, BA0 for 64M SDRAM, unused on 16M	2mA (SL)

Table 18: STV0681 pin listing

Pin no.	Signal	Type	Description	drive
28	AD13	Output	SDRAM address A13, BA1 for 64M SDRAM, unused on 16M	2mA (SL)
25	CS	Output, active low	Chip select: enables (registered LOW) and disables (registered HIGH) the SDRAM command decoder.	2mA (SL)
23	RAS	Output, active low	SDRAM row address strobe command	2mA (SL)
21	CAS	Output, active low	SDRAM column address strobe command	2mA (SL)
19	WE	Output, active low	SDRAM write enable command	2mA (SL)
18	DQML	Output	Data input/output mask for dram_DQ[7:0]	2mA (SL)
100	DQ0	Input/Output	SDRAM Data Bus	2mA (SL)
2	DQ1	Input/Output	SDRAM Data Bus	2mA (SL)
4	DQ2	Input/Output	SDRAM Data Bus	2mA (SL)
6	DQ3	Input/Output	SDRAM Data Bus	2mA (SL)
8	DQ4	Input/Output	SDRAM Data Bus	2mA (SL)
10	DQ5	Input/Output	SDRAM Data Bus	2mA (SL)
14	DQ6	Input/Output	SDRAM Data Bus	2mA (SL)
16	DQ7	Input/Output	SDRAM Data Bus	2mA (SL)
17	DQ8	Input/Output	SDRAM Data bus	2mA (SL)
15	DQ9	Input/Output	SDRAM Data bus	2mA (SL)
13	DQ10	Input/Output	SDRAM Data bus	2mA (SL)
9	DQ11	Input/Output	SDRAM Data Bus	2mA (SL)
7	DQ12	Input/Output	SDRAM Data Bus	2mA (SL)
5	DQ13	Input/Output	SDRAM Data Bus	2mA (SL)
3	DQ14	Input/Output	SDRAM Data Bus	2mA (SL)
1	DQ15	Input/Output	SDRAM Data Bus	2mA (SL)

Table 18: STV0681 pin listing

Pin no.	Signal	Type	Description	drive
LCD Interface				
83	LCDCOM	Output	LCD Common	4mA (SL)
93	LCD1_6	Output	LCD digit 1 segment G	2mA (SL)
94	LCD1_5	Output	LCD digit 1 segment F	2mA (SL)
95	LCD1_4	Output	LCD digit 1 segment E	2mA (SL)
96	LCD1_3	Output	LCD digit 1 segment D	2mA (SL)
97	LCD1_2	Output	LCD digit 1 segment C	2mA (SL)
98	LCD1_1	Output	LCD digit 1 segment B	2mA (SL)
99	LCD1_0	Output	LCD digit 1 segment A	2mA (SL)
86	LCD2_6	Output	LCD digit 2 segment G	2mA (SL)
87	LCD2_5	Output	LCD digit 2 segment F	2mA (SL)
88	LCD2_4	Output	LCD digit 2segment E	2mA (SL)
89	LCD2_3	Output	LCD digit 2segment D	2mA (SL)
90	LCD2_2	Output	LCD digit 2segment C	2mA (SL)
91	LCD2_1	Output	LCD digit 2 segment B	2mA (SL)
92	LCD2_0	Output	LCD digit 2 segment A	2mA (SL)
Piezo Interface				
82	PIEZO	Output	Direct connection to piezo buzzer	8mA (SL)
Battery Level Comparator Interface				
78	LO_BAT	Input (A)	Battery level comparator input. The voltage on low_bat is compared to the reference to determine the battery status	
77	LO_BAT_REF	Input (A)	1.22V battery level comparator reference input	

Table 18: STV0681 pin listing

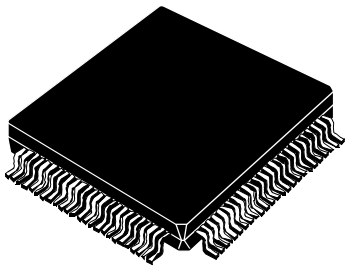
Pin no.	Signal	Type	Description	drive
Power and Ground				
12, 38, 70, 84	DVSS	Power pin	Digital Ground	
11, 39, 69, 85	DVDD	Power pin	Digital Power	
76	AUD_VSS	Power pin	Audio DAC Ground. Requires clean supply.	
81	AUD_VDD	Power pin	Audio DAC Power. Requires clean supply.	
53	PLLGVSS	Power pin	PLL Guard Ground	
51	PLLAVDD	Power pin	PLL Analog Power	
52	PLLAVSS	Power pin	PLL Analog Ground	
Non-user pins				
45	TEST0	Input	Non-user pin - connect to 3V3	
46	TEST1	Input	Non-user pin - connect to 3V3	
47	TEST2	Input	Non-user pin - connect to 3V3	
79	DACRES	I(A)	DAC bias amplifier reference input.	
80	DACOUT	O (A)	8-bit DAC current source output.	0-10mA

Key	
SL	slew rate limited output
OD	open drain output
S	Schmidt input
A	analogue input/output
T	5V tolerant pad (these pads do not have diode protection)

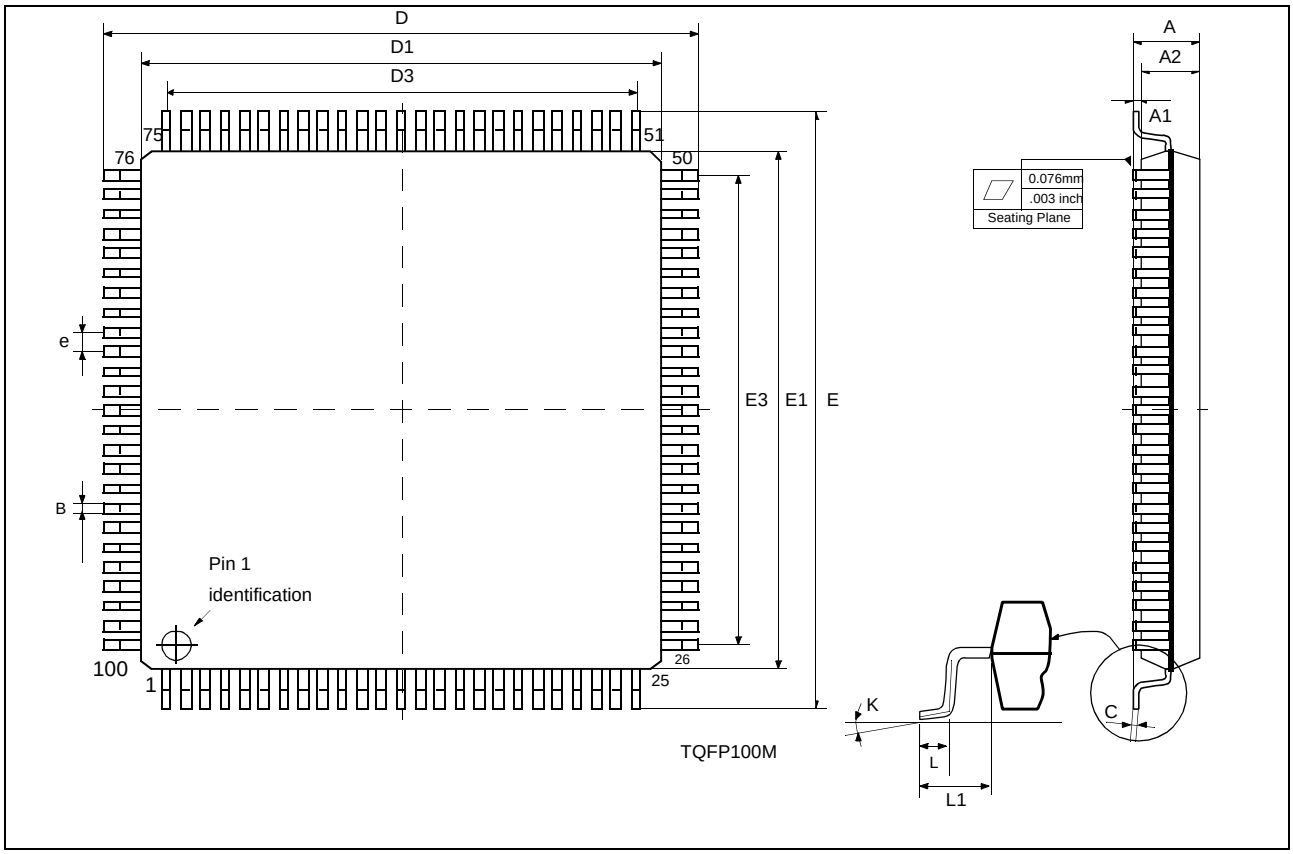
Note: 1 Where the I/O pad type is not explicitly defined, assume CMOS.

8 STV0681 package mechanical data

Dim.	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.60			0.063
A1	0.05		0.15	0.002		0.006
A2	1.35	1.40	1.45	0.053	0.055	0.057
B	0.17	0.22	0.27	0.007	0.009	0.011
C	0.09		0.20	0.003		0.008
D		16.00			0.630	
D1		14.00			0.551	
D3		12.00			0.472	
e		0.50			0.019	
E		16.00			0.630	
E1		14.00			0.551	
E3		12.00			0.472	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.0393	
K	3.5° (min.), 7° (max.)					



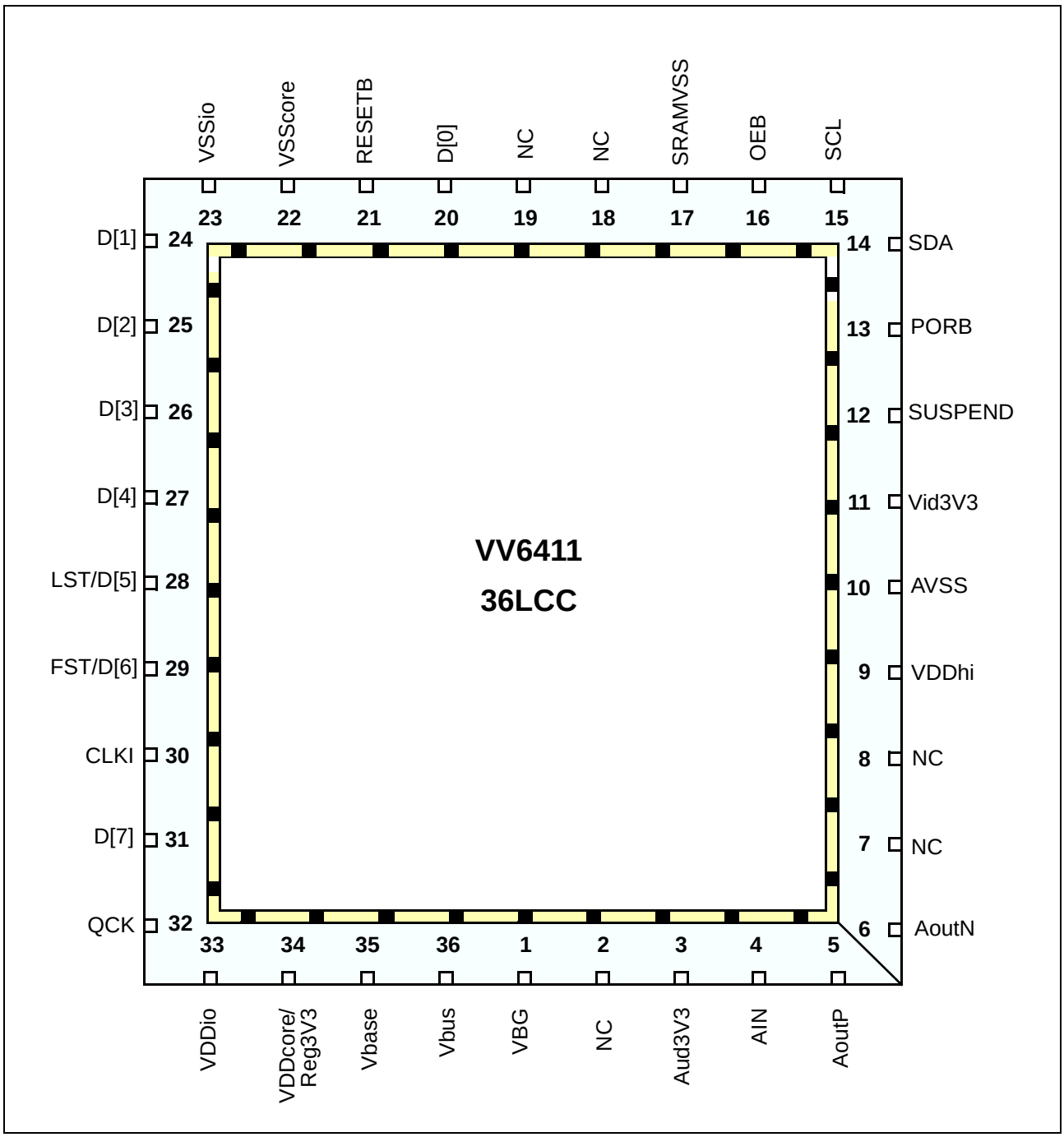
TQFP100



9 VV6411 pin description

9.1 VV6411 pinout

Figure 7: 36 pin LCC package pin assignment



9.2 VV6411 pin description

Table 19: VV6411 pin description

Name	Pin Number	Type	Description
Power supplies			
AVSS	10	GND	Core analogue ground and reference supplies.
SRAMVSS	17	GND	In-column SRAM analogue ground.
VDDcore/ Reg3V3	34	PWR	Digital logic power.
VDDio	33	PWR	Digital pad ring power.
VSScore	22	GND	Digital logic ground.
VSSio	23	GND	Digital pad ring ground.
Analogue signals			
VBG	1	OA	Internally generated bandgap reference voltage 1.22V
AIN	4	IA	Analogue input to Audio Amplifier
AOutP	5	OA	Analogue output of Audio Amplifier (positive)
AOutN	6	OA	Analogue output of Audio Amplifier (negative)
VDDHI	9	IA	Incoming power supply 4 -> 6V
VBase	35	OA	Drive for base of external bipolar
Vbus	36	IA	Incoming power supply 3.3 -> 6V
Aud3V3	3	OA	On-chip Audio Amplifier Voltage Regulator Output
Vid3V3	11	OA	On-chip Video Supply Voltage Regulator Output
PORB	13	OD	Power-on Reset (Bar) Output.
Digital video interface			
D[4] D[3] D[2] D[1] D[0]	27 26 25 24 20	ODT	Tri-stateable 5-wire output data bus. - D[4] is the most significant bit. - D[4:0] have programmable drive strengths 2, 4 and 6 mA
QCK	32	ODT	Tri-stateable data qualification clock.
LST/D[5]	28	ODT	Tri-stateable Line start output May be configured as tri-stateable output data bit 5 D[5].
FST/D[6]	29	ODT	Tri-stateable Frame start signal. May be configured as tri-stateable output data bit 6 D[6].
D[7]	31	ODT	Tri-stateable Data wire (ms data bit). May be configured as tri-stateable output data bit 6 D[6].
OEB	16	ID↓	Digital output (tri-state) enable.

Table 19: VV6411 pin description

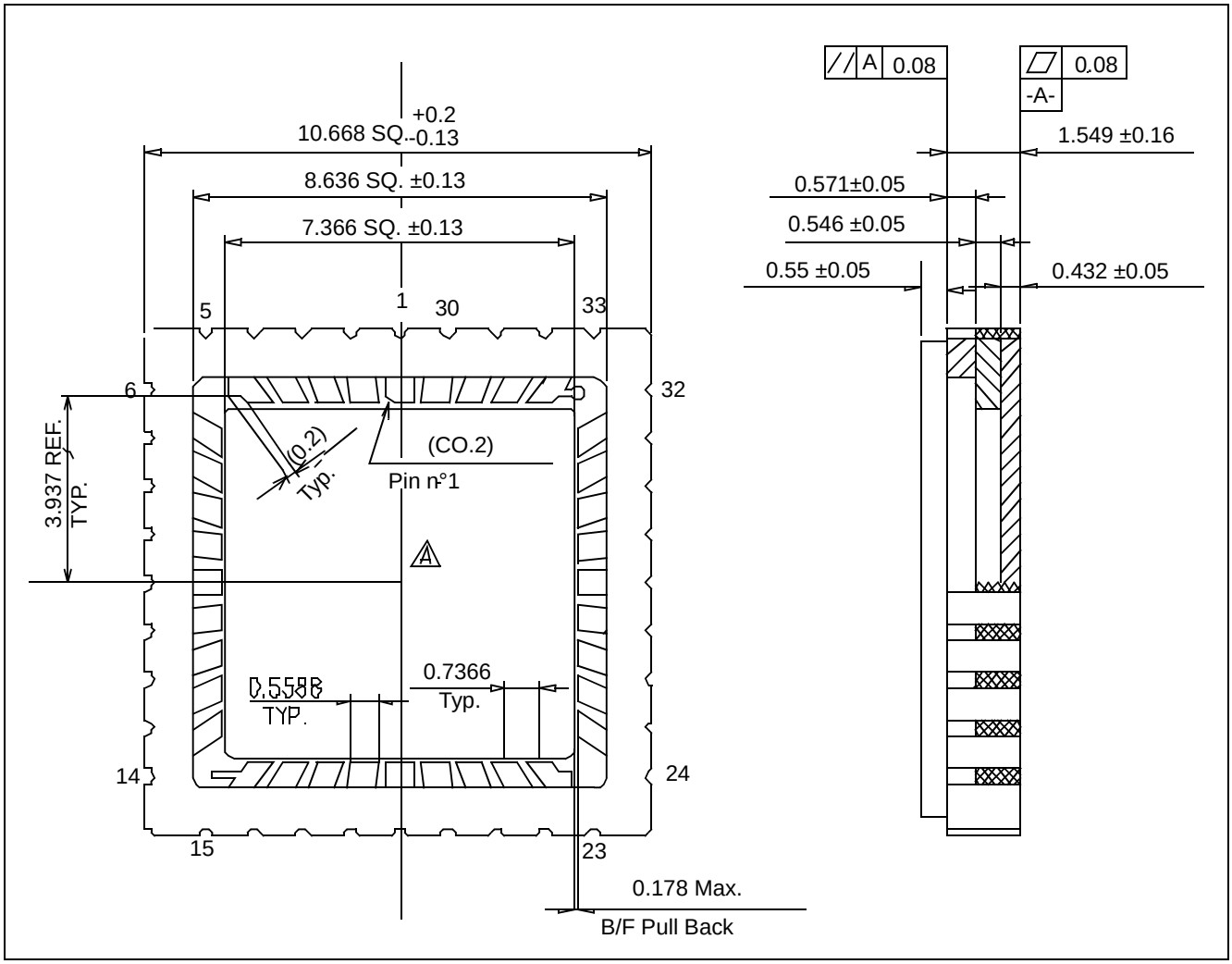
Name	Pin Number	Type	Description
Digital control signals			
RESETB	21	ID↑	System Reset. Active Low. May be configured as System Sync. Active Low.
SUSPEND	12	ID↑	USB Suspend Mode Control signal. Active High If this feature is not required then the support circuit must pull the pin to ground. The combination of an active high signal and pull up pad was chosen to limit current drawn by the device while in suspend mode.
Serial interface			
SCL	15	BI↑	Serial bus clock (input only).
SDA	14	BI↑	Serial bus data (bidirectional, open drain).
System clocks			
CLKI	30	ID↓	Schmitt Buffered Clock input or LVDS positive Clock input
Not connected			
NC	2, 7, 8, 18, 19		Not connected

Key			
A	Analogue Input	D	Digital Input
OA	Analogue Output	ID↑	Digital input with internal pull-up
BI	Bidirectional	ID↓	Digital input with internal pull-down
BI↑	Bidirectional with internal pull-up	OD	Digital Output
BI↓	Bidirectional with internal pull-down	ODT	Tri-stateable Digital Output

10 VV6411 package mechanical data

(36pin LCC)

Figure 8: VV6411 36LCC Package Detail

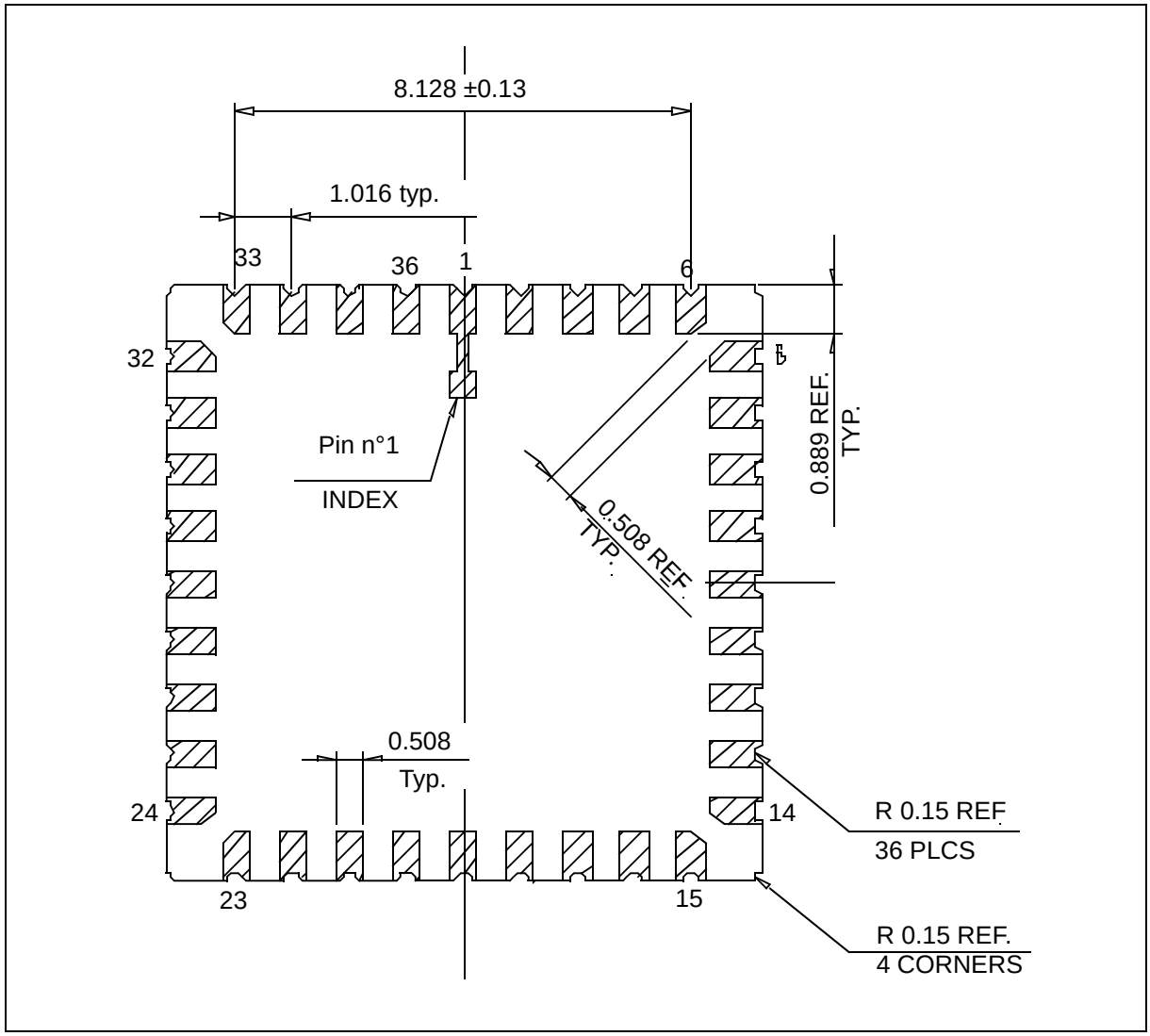


Note: 1 Die is optically centred

2 Refractive Index of Glass is approx. 1.52

.

Figure 9: VV6411 36LCC Package Detail



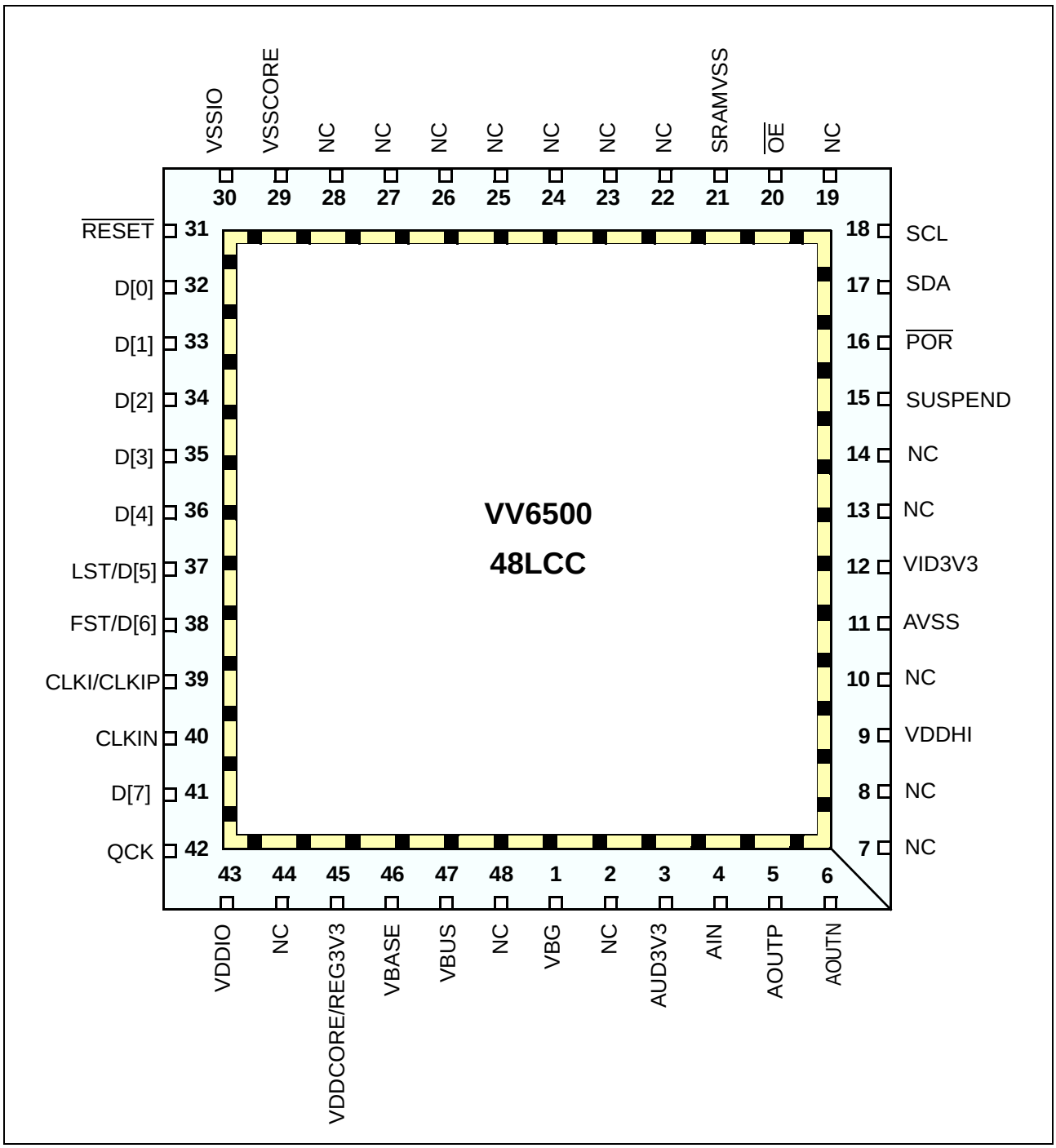
Note: 1 Die is optically centred

2 Refractive Index of Glass is approx. 1.52

11 VV6500 pin description

11.1 VV5500 pinout

Figure 10: 48 pin LCC package pin assignement



11.2 VV6500 pin description

Table 20: VV6500 pin description

Name	Pin Number	Type	Description
Power supplies			
AVSS	11	GND	Core analogue ground and reference supplies.
SRAMVSS	21	GND	In-column SRAM analogue ground.
VDDio	43	PWR	Digital pad ring power.
VSScore	29	GND	Digital logic ground.
VSSio	30	GND	Digital pad ring ground.
SRAMVSS	21	GND	In-column SRAM analogue ground.
Analog signals			
VBG	1	OA	Internally generated bandgap reference voltage 1.22V
AIN	4	IA	Analogue input to Audio Amplifier
AOutP	5	OA	Analogue output of Audio Amplifier (positive)
AOutN	6	OA	Analogue output of Audio Amplifier (negative)
VDDHI	9	IA	Incoming power supply 4 -> 6V
VBase	46	OA	Drive for base of external bipolar
Vbus	47	IA	Incoming power supply 3.3 -> 6V
VDDCORE/ REG3V3	45	OA	On-chip Voltage Regulator Output
Aud3V3	3	OA	On-chip Audio Amplifier Voltage Regulator Output
Vid3V3	12	OA	On-chip Video Supply Voltage Regulator Output
PORB	16	OA	Power-on Reset (Bar) Output.

Table 20: VV6500 pin description

Name	Pin Number	Type	Description
Digital video interface			
D[4] D[3] D[2] D[1] D[0]	36 35 34 33 32	ODT	Tri-stateable 5-wire output data bus. - D[4] is the most significant bit. - D[4:0] have programmable drive strengths 2, 4 and 6 mA
QCK	42	ODT	Tri-stateable data qualification clock.
CLKIN	40	BI↑	LVDS negative Clock input
LST/D[5]	37	ODT	Tri-stateable Line start output May be configured as tri-stateable output data bit 5 D[5].
FST/D[6]	38	ODT	Tri-stateable Frame start signal. May be configured as tri-stateable output data bit 6 D[6].
D[7]	41	ODT	Tri-stateable Data wire (ms data bit). May be configured as tri-stateable output data bit 6 D[6].
OEB	20	ID↓	Digital output (tri-state) enable.
Digital control signals			
RESETB	31	ID↑	System Reset. Active Low. May be configured as System Sync. Active Low.
SUSPEND	31	ID↑	USB Suspend Mode Control signal. Active High If this feature is not required then the support circuit must pull the pin to ground. The combination of an active high signal and pull up pad was chosen to limit current drawn by the device while in suspend mode.
Serial interface			
SCL	18	BI↑	Serial bus clock (input only).
SDA	17	BI↑	Serial bus data (bidirectional, open drain).
System clocks			
CLKI/CLKIP	39	ID↓	Schmitt Buffered Clock input or LVDS positive Clock input
Not connected			
NC	2, 7, 8, 10, 13, 14, 19, 22-28, 44, 48		Not connected

Key			
A	Analogue Input	D	Digital Input
OA	Analogue Output	ID↑	Digital input with internal pull-up
BI	Bidirectional	ID↓	Digital input with internal pull-down
BI↑	Bidirectional with internal pull-up	OD	Digital Output
BI↓	Bidirectional with internal pull-down	ODT	Tri-stateable Digital Output

12 VV6500 package mechanical data

Figure 11: VV6500 Package details

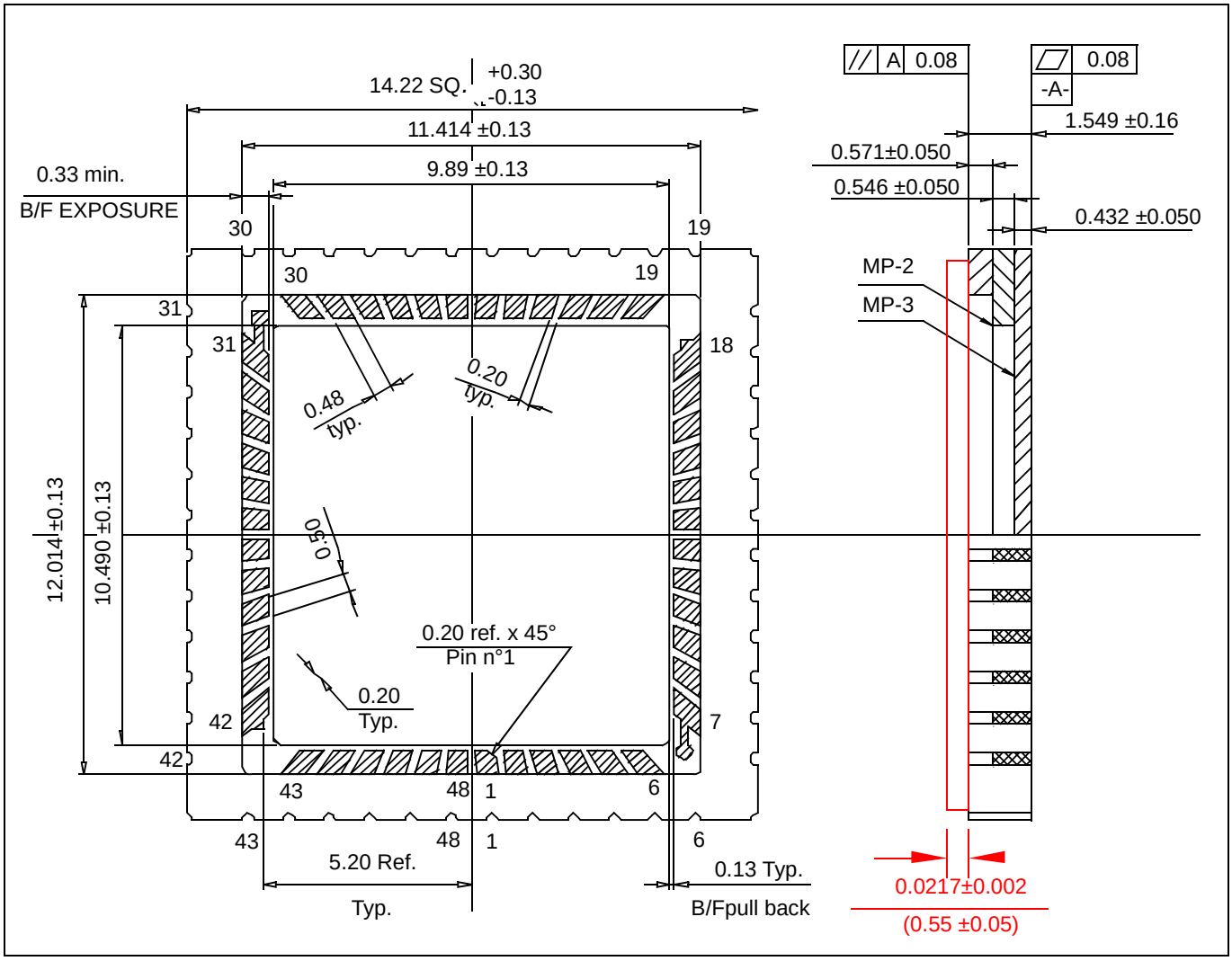
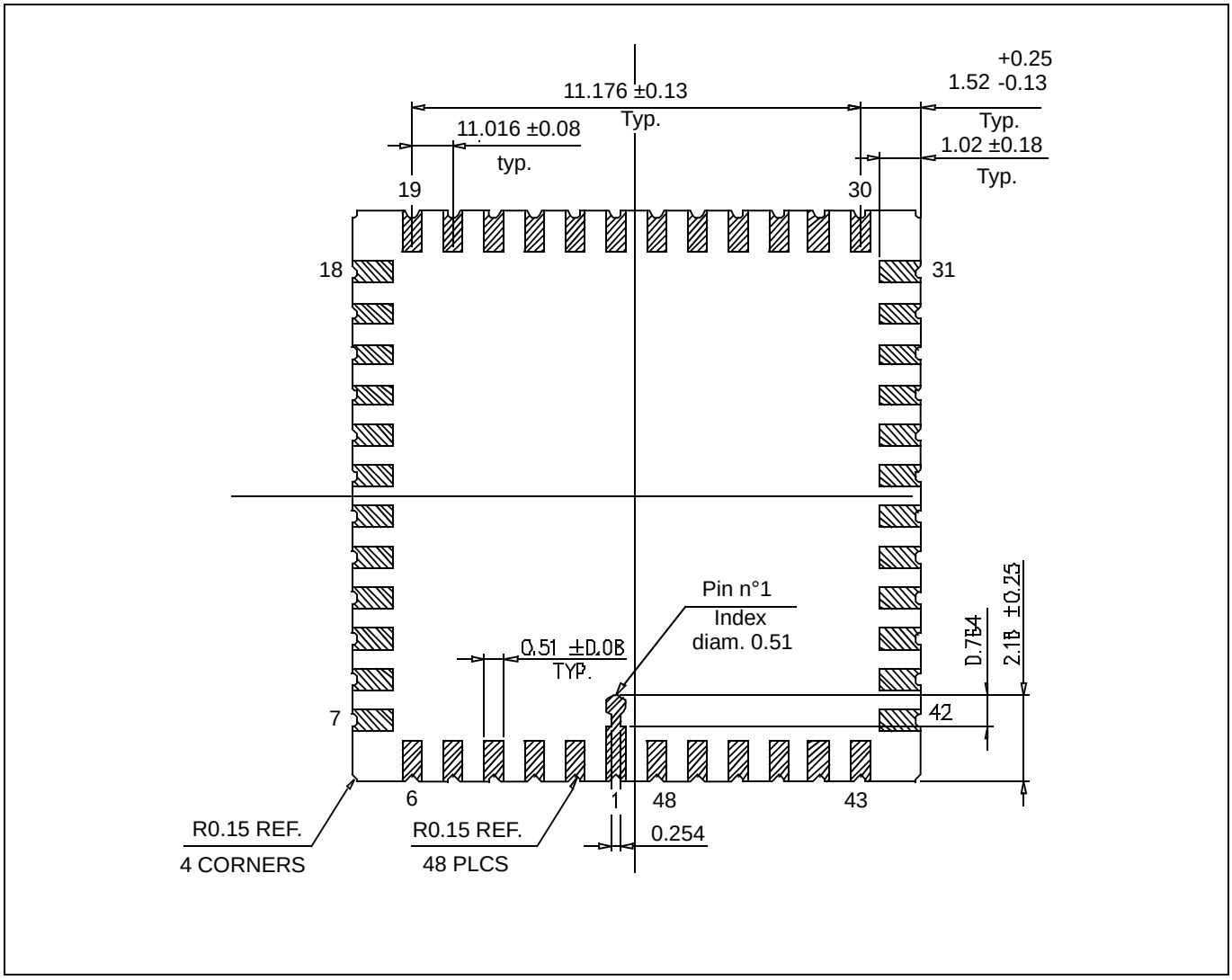


Figure 12: VV6500 Package details



Note: 1 Die is optically centred

2 Refractive Index of Glass is approx. 1.52

13 Evaluation Kit (EVK)

STMicroelectronics can supply an Evaluation Kit for initial evaluation and design-in.

The EVK includes an STV0681 Motherboard PCB and two lensed sensor daughter boards (VV6411 (CIF) and VV6500 (VGA)). Additional motherboards and daughter boards may be ordered separately. The EVK PCB includes SDRAM memory, connectors, numeric LCD display, battery holder, push buttons/switches, audio record and playback circuitry, flashgun interface circuitry, and a flashgun hotshoe connector (to allow the use of a standard camera flashgun). Optional PCB links enable alternate functionality, and demonstration software is included, allowing for tethered video, upload to the PC of pictures, sounds, and AVI movie clips, and download to the camera of custom sounds.

A reference design manual, giving the camera designer everything required for standard features and Audio record/playback is available, including schematics, explanatory notes, parts list, and layout advice.

13.1 Ordering details

Table 21: Ordering details for STV0681 + VV6411/6500 Evaluation Kits

Description	Part number
STV0681 companion processor	STV0681
VV6411 CIF Colour CMOS sensor (36LCC package)	VV6411C036
VV6500 VGA Colour CMOS sensor (48LCC package)	VV6500C001
Complete Evaluation Kit	
STV0681 Complete Evaluation Kit (includes STV-681-M01, STV-6411C-D01 and STV6500C-D01)	STV-681-E01
Additional EVK Components	
Evaluation Kit Motherboard	STV-681-M01
Sensor Daughter Board with VV6411	STV-6411C-D01
Sensor Daughter Board with VV6500	STV-6500C-D01

Note: All Evaluation Kits include hardware and software support for Audio, Custom sounds, and Flashgun features.

13.2 Technical support

Technical support information, such as datasheets, software downloads,etc, for products of the STMicroelectronics Imaging Division can be found at **www.st.com** (click on Imaging products)

General sales/technical enquiries can be directed to regional email contacts:
asiapacific.imaging@st.com

centraleurope.imaging@st.com

france.imaging@st.com

japan.imaging@st.com

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