TECHNICAL DESCRIPTION

The unit is powered by a 4.5V d.c. (3 x 3A battery). It has internal 64Mb memory which can be stored the pictures in digital format. By using the USB interface, the pictures can be transferred to PC.

II C BUS

An II C Bus controller is included. It is typically attached to the CMOS Sensor that can be used to extend the peripheral controls to additional buttons and LCD display.

GENERAL PURPOSE I/O

There are eight general purpose I/O pins which can be used for key inputs and able to direct drive the LCD driver HT1621 without any additional circuitry needed.

LCD DISPLAY

A LCD Display Driver HT1621 can be used and direct driven by STV0680B for a three-digit icon LCD display without any additional circuitry needed.

ADDRESS AND DATA BUS

Fourteen_address bus is available for pointing up to 16k locations. Sixteen_data bus is available for accessing 2 bytes of data (one word) simultaneously in order to speed up the data movement.

3/3

MEMORY INTERFACE

STV0680B can be connected up to 64Mbytes SDRAM for data storage.

SENSOR INTERFACE

A ST VV6500 VGA CMOS Sensor can be directly implemented into STV0680B to give a picture quality with 300,000 pixels.

USB INTERFACE

External interface to a host computer is typically obtained by USB interface. A USB interface circuitry is built-in the STV0680B for in order to simply the interface circuitry to computer.

1.1 General

This document gives the designer all the information required to produce a low cost dual-mode (Stills/Videoconferencing) Digital Camera using the CMOS chipset STV0680B (DCA1)+VV6410/6500 from STMicroelectronics. Such a camera is particularly suited to digital stills or toy applications. Schematics, explanatory notes, bill of materials, and PCB layout advice are given.

Example layout plots are shown for the Evaluation Kit PCB. Although these show a different circuit (i.e. one which includes several un-documented options), it would be possible to build a camera using the example layout plots and parts list shown, whilst consulting the text in this document to understand the fitting options. However, for best performance, this is **not** recommended, it is much better to design a camera from the start, using this reference design, to allow various functional improvements to be included.

1.2 Design migration from cameras using VV6444 to cameras using VV6410/6500

Note the following:

1. VV6410/6500 both have a different pinout, lens format, and supply voltage (3V3) to VV6444.
2. VV6410/6500 require simplified power supply circuitry compared to VV6444.

Hence the design shown in this document is only suitable for cameras using VV6410 or VV6500. A separate reference design is available for cameras using VV6444, please contact ST for details.

1.3 Design migration from using STV0680/STV0680A to using STV0680B

Three revisions of the co-processor have been produced by ST. Although there are certain functional differences between these revisions, all three have an identical pinout and are completely interchangeable within a design. At the time of writing, the current production version is STV0680B, hence STV0680B is referred to in all cases, except when explaining specific differences between revisions.

Note the following regarding the differences between the co-processor revisions:

- STV0680A uses different silicon and different firmware compared to STV0680. Functionally it is exactly the same as STV0680 except that it supports a VfW driver and RS232 interface. In addition, a different firmware variant (v1.00) means that the STV0680A also supports VV6410 and VV6500 sensors, as well as 64Mbit memory size.
- STV0680B uses different silicon to STV0680A but the same firmware variant (v1.00). Functionally it is exactly the same as STV0680 and STV0680A except that it has a low standby current (<50uA), allowing for longer battery life in Standby mode, and making USB compliance in PC Suspend mode easier to achieve (see Section 3.5.3).

Order number	Silicon revision	Firmware revision	Sensors supported	SDRAM supported	USB	RS232	Video for Windows support
STV0680-001	STV0680	v0.87	VV6444	16Mbit onl	Yes	No	No
STV0680A-002	STV0680A	v1.00	VV6444, VV6410, VV6500	16Mbit or 64Mbit	Yes	Yes	Yes
STV0680B-001	STV0680B	v1.00	VV6444, VV6410, VV6500	16Mbit or 64Mbit	Yes	Yes	Yes

Table 1 : Differences between STV0680, STV0680A, and STV0680B

1.4 Chipset datasheet

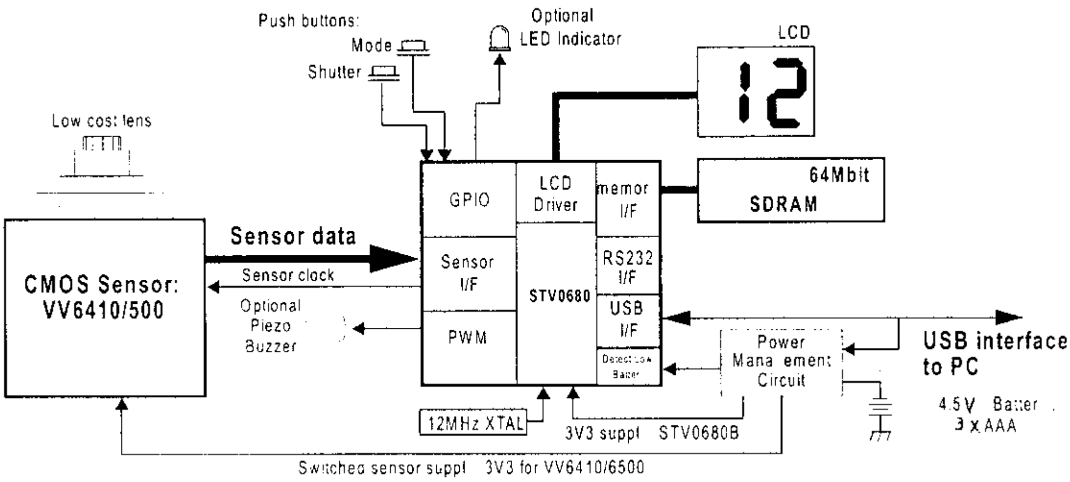
This document should be used with the following datasheet, available separately, please contact STMicroelectronics for details:

- STV0680B+VV6444/6410/6500 Digital Camera Chipset: Customer Datasheet.

1.5 Software support

Complete software support for the camera chipset is available from STMicroelectronics. See Section 6.

Application Block Diagram



Typical camera system block diagram

Both RS232 and USB interfaces are shown on the schematics and parts list. Please take careful note of the population options as explained.

2.1 USB camera

- For a USB camera, none of the RS232 interface components are required. Image download will be considerably faster than RS232 and tethered video modes can be used. If USB only is implemented (no RS232), the RXD pin (59) should be tied to the TXD pin (58), using R65.
- Please refer to Section 3.5.4 for USB connector advice, whether or not USB compliance is required.
- For USB compliance, a standard USB type B connector must be used.

2.2 RS232 camera

- For a RS232 camera, the power supply is greatly simplified, since the camera will be powered by the battery at all times. Therefore USB detection circuitry and power switching circuitry are not required. The build cost will be lower but image download will be much slower than USB, and tethered video modes cannot be supported, so lens focusing in production will be more difficult.
- Ideally, test pads should be included to allow a USB connection during production for checking the lens focussing. These test points are shown as TP1-6. The USBDET net should be connected as shown, otherwise STV0680B will not connect to USB.
- An RS232 camera without USB test pads for production should have USB+, USB-, and USBDET connected as shown.
- For the RS232 connection, a 3.5mm stereo jack socket is suitable. For interface circuitry, a standard Maxim transceiver chip may be preferable to the discretes solution shown.

The key elements of the power supply are:

- Permanent 3v3 supply to STV0680B and SDRAM
- 3v3 supply to sensor
- Supply from USB bus, can vary from 4.3 - 5.25v
- Supply from battery, depends on battery type

3.1 Power supply options for Standby/Suspend mode

The permanent 3v3 supply to STV0680B and SDRAM is required at all times, even when the camera is in Standby Mode/PC Suspend Mode.The 3v3 supply to sensor can be disabled for power saving, but only if separate supplies are used. There is a trade-off between lowest cost and lowest current consumption, hence two options are shown in the schematics:

Option 1(as per Revision 1.0): The permanent 3v3 supply to STV0680B and SDRAM comes from the sensor on-board Voltage regulator together with an external bipolar Q10 to regulate the USB or battery supply to 3V3. It means that the sensor cannot be switched off when the camera is in Standby Mode/PC Suspend Mode, because this would remove the supply to STV0680B and the SDRAM. Hence the sensor Suspend mode is utilised in such modes, which has a maximum current consumption of 100µA for VV6410 and VV6500. This has an impact on battery life in Standby Mode, and given the limited power budget for PC Suspend Mode, makes USB compliance harder to achieve.

So Option 1has slightly higher current consumption in Standby Mode/PC Suspend Mode but this is a lower cost solution since it removes the requirement for any external 3V3 regulator.

Option 2 (new option): The permanent 3v3 supply to STV0680B and SDRAM uses a separate 3v3 linear VReg (must have low quiescent current), while sensor on-board Voltage regulator is used to supply the sensor. This allows the supply to the sensor to be switched off completely in Standby Mode/PC Suspend Mode. which saves up to 100µA, which will improve the battery life in Standby Mode. and should make USB compliance easier to achieve.

So Option 2 requires some extra cost (principally a 3v3 Linear Vreg U11 and a Power on rest chip U8), but it consumes less current in Standby Mode/PC Suspend Mode.

Note: Option 2 has not been tested for USB compliance.

3.2 Separation of supplies

In general, the digital supplies (to sensor digital circuits. driven by VDDIO/VDDCORE, and STV0680B/SDRAM) should be kept separate from the sensor analog supply (driven by the sensor VBUS pin) as much as possible. Therefore direct driving of the sensor digital circuits using the same 3v3 Vreg as the STV0680B/SDRAM is not advised. This was tried in Rev 0.1. of the Reference Design and exists on some early EVK units, but noise crossover issues were intrduced, hence direct driving in this manner is not recommended. Options 1 and 2. shown above, both give best noise rejection by keeping the supplies separate.

In order to keep supplies separate. careful consideration should also be made of PCB layout advice as given in Section 4.6.

3.3 Battery size

The power supply schematic shown can be used with a 4.5-6V battery only. The VBUS sensor input on VV6410/6500 has a max. input rating of 6V. The dropout voltage of the sensor VReg is approx. 4.1v. The sensor VReg will still operate below this voltage on VBUS. but with a risk of compromised image quality.

The diode D1 is recommended to protect against reverse battery fitting, and to prevent excessive current draw from the USB if the camera is connected with very low batteries.

Please also note the following:

1. If 4 x AA batteries are used. the voltage on the sensor VBUS pin must be limited to below 6v, since the voltage from 4 fresh AA Alkaline batteries is at least 6.3v. Hence a Schottky diode must be used for D1, a general purpose diode such as 1N4001 would be suitable.
2. If 3 x AA batteries are used. a Schottky diode can be used for D1. A general purpose diode could still be used but the battery life would be reduced.
3. For a 9v battery circuit. see Section 3.10.

3.4 Battery type

The circuit shown assumes Alkaline batteries are used. The possibilities of using Ni Cad batteries are discussed Section 3.6.3 and Section 3.6.4.

3.5 USB compliance

If USB compliance is a requirement, the following are some of the hardware considerations.

- Ability to enumerate to the PC without batteries fitted - see Section 3.5.1.
- Protection against inrush current as per USB specification - see Section 3.5.2.
- Current consumption <500µA in PC Suspend Mode when connected to USB cable, for a low power device - see Section 3.5.3.
- Compliant USB cable and connectors (Standard type B) - see Section 3.5.4.

Note: The above does NOT constitute a complete list of USB compliance requirements for the camera hardware. However, all of the above are included in the USB specification Revision 1.1, which should be consulted in more detail.

3.5.1 Detection of USB connection and isolation of battery

To allow the camera to enumerate to the PC , the camera must be able to detect the USB connection and draw power from USB. It is also desirable to disable the battery when connected to the USB (by switching off the PFET Q8, using R7, R8, R14, R13, Q2, Q3), to save battery power.

It is possible to bypass the PFET Q8 and not fit R7, R8, R14, R13, Q2, Q3 - this would mean the battery is always used as the power source, as long as its voltage (minus diode drop D1) exceeds the USB supply voltage (minus D2 diode drop). This would reduce the BOM cost but would (a) significantly decrease the battery life, and (b) prevent the camera being able to enumerate to the PC even with flat/removed batteries.

Even if power sourcing from USB is not included as part of the camera spec, the USBDET pin still needs connected as shown (R9/R1), otherwise STV0680B cannot communicate through USB. This would be the case for a camera which is designed primarily for RS232, but still includes test points to connect to USB for production test, to allow continuous capture for lens focussing.

Note that the diode D2 must be low leakage, otherwise there is a risk that the leakage current through D2 from the battery could cause the USBDET and BATT_OFF nodes to indicate that USB is connected.

3.5.2 USB inrush protection

To comply with USB requirements for limited current inrush when the camera is plugged into the USB bus without batteries fitted, a suitable circuit is shown. The same inrush circuit with R2=1R2 and C34 = 10uF has passed a USB I.F. Plugfest test of an EVK, for inrush current with no battery fitted. However, note that actual USB compliance is the ultimate responsibility of the OEM, and USB I.F. tests are continually being updated, therefore consultation of the USB specification latest revision is recommended.

Where limitation of current inrush is not an issue, fit R6, and do not fit Q9, R2, Q5, R12.

3.5.3 Low current consumption in PC Suspend Mode

If USB compliance is a requirement, current USB requirements specify that for a low power device, current consumption should be <500µA in PC Suspend Mode when connected to the PC through USB. This means that :

1. In PC Suspend mode (i.e. while tethered to the PC), 200µA is consumed by R21 (1k5) and a 15k pull down in the PC.So the camera itself can only consume 300µA.
2. This implies that in Standby mode (i.e. while untethered), current consumption of the total camera will be <300µA.

	USB complience requirements may change with respect to PC Suspend mode current. Please consult the USB I.F. for up to date information.

Therefore to calculate the Standby mode and PC Suspend mode currents, use the following:

- The current consumption budget in Standby Mode (i.e. not tethered to USB) = **(STV0680B standby current)+(SDRAM self-refresh current)+(VV6410/6500 Suspend mode current)+(Peripheral circuitry)**
- The current consumption budget in PC Suspend Mode (i.e. Tethered to USB and Suspend mode actioned by PC Driver) = **(Current consumption budget in Standby Mode)**+200µA

1. **STV0680B standby current**: Please consult the STV0680B+VV6444/6410/6500 Digital Camera Chipset: Customer Datasheet for up to date information. STV0680-001/680A-002 both exhibit higher than expected current consumption.
2. **SDRAM self-refresh current**: This depends entirely on the SDRAM, an SDRAM with as low self-refresh current as possible should be sourced. Suggestions have been made in Section 11., however these are only from limited evaluation, no guarantee can made regarding availability or specification of SDRAM.
3. **VV6410/6500 Suspend mode current**: As explained in Section 3.1:
   - Using option 1, the sensor cannot be powered off in PC Suspend mode hence up to 100μA is consumed by the sensor.
   - Using option 2, the sensor is powered off, hence the sensor current consumption in PC Suspend is negligible.
4. **Peripheral circuitry**: No more that 50μA can be expected if the implementation shown is used.

3.5.4 USB connector (J1)

Only standard compliant USB connectors can be used if USB compliance is required.

For camera design, whether or not USB compliance is required, a non-standard connector could cause driver problems and even cause permanent damage to the camera or PC, if the connector design allows the data (D+ and D-) pins to become connected before or at the same time as the USB_VCC and GND pins. The compliant USB type B connector allows for this, please consult the USB specification 1.1, however if a non-compliant custom connector is to be used, consult Figure 2.

Note: At the time of writing, the USB Implementers Forum may be about to approve a minature USB connector which allows a lower profile camera casing to be designed. Please consult ______________ for updated details.

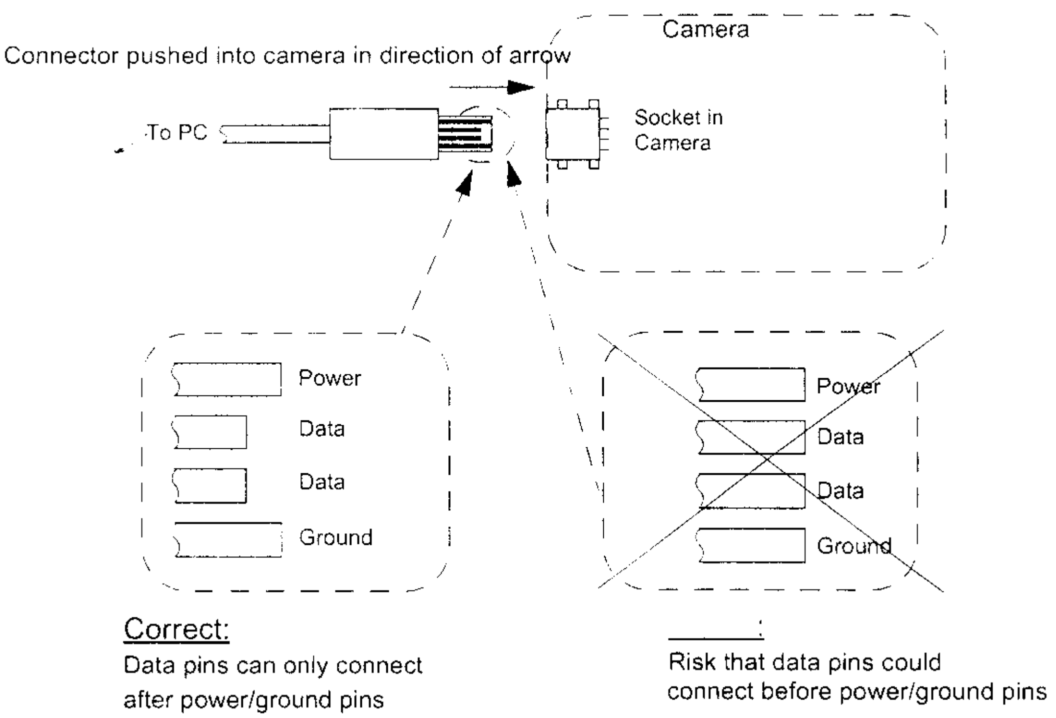


Figure 2 : Correct design of custom USB connector (non compliant)

3.6 Low battery detection

The STV0680B includes a function which causes the LCD display to flash when the camera battery voltage falls below a predetermined threshold. This is known as a Low Battery condition. This is only checked by the STV0680B when it does not detect a USB connection.

3.6.1 General

The voltage divider R10 and R11 compares the voltage LO_BAT with the sensor bandgap voltage 1.22V. The value for R11 can be calculated, based on the required battery cut-off point. Note that in a change to previous designs, D1 has been moved, hence the diode drop of D1 is not relevant for calculating the value of R11, but it is still relevant for deciding what the required cut-off point for the battery should be.

In theory, the battery voltage minus the diode drop of D1 could go as low as the minimum voltage required to operate the camera. In practise, this would be not be so good, because the battery would have hardly any energy left to allow the user time to get to a PC for image upload. Hence we assume in the following calculations that a good cut off point is a battery voltage of 1.2V per cell.

3.6.2 Calculating value of R11

1. R11 = 330k, threshold voltage = ((1M+330k)/330k * 1.22) = 4.91v. Hence this would be a good cutoff voltage for four AA batteries, where the voltage per cell reaches 1.23v.
2. R11 = 510k, threshold voltage = ((1M+510k)/510k * 1.22) = 3.61v. Hence this would be a good cutoff voltage for three AA batteries, where the voltage per cell reaches 1.2v.

For a 9v battery, see Section 3.10.

3.6.3 Ni-Cad Batteries

If the circuit has been designed for Alkaline batteries (using the values shown in Section 3.6.2), then the camera user manual should tell the camera user not to use Ni-cad batteries, because the cell voltage of a fresh NI-Cad battery (1.2v) is similar to the cell voltage of a discharged Alkaline battery. The resitor values suggested in Section 3.6.2 are intended for Alkaline batteries and would mean that a "Low battery" condition is always detected with Ni-Cad batteries, even when fresh.

The alternative is to set a much lower "low battery" threshold (i.e. a higher value of R11), but this would risk the situation that if the user inserts Alkaline batteries into the camera, the "low battery" condition might be detected too late - when the batteries would have virtually no life left to allow the user time to get to a PC for image upload.

3.6.4 Camera re-charge from USB

It is possible to design a camera which recharges from the USB bus, particularly if using Sintered AA size Ni-Cad cells. If implementing a slow charge, the actual hardware design required is fairly simple, as long as USB requirements are allowed for. Please contact ST for advice

3.7 Optional battery-off switch (SW1)

This may be desirable to save battery life when the camera is not in use, and no pictures need to be stored. The camera user manual should tell the camera user that **opening this switch will lose all images stored in the camera**, in the same way as removing the batteries. This switch could be placed in the housing so that it is not easily accessible.

3.8 Using three 1.5V batteries

The schematics shown are suitable for three AA or AAA cells only if:

- The Diode D1 is a Schottky, to give smaller voltage drop (note, however that the Schottky could damage the sensor if used with 4 AA or AAA batteries, as explained in Section 3.3).
- The resistor R11 is changed as per Section 3.6.2.

A battery isolation switch SW1 is recommended as per Section 3.7, due to the reduced battery capacity.

With 3 AAA or AA cells, it may be possible to bypass the PFET Q8 battery isolation circuit (hence remove Q8, Q2, Q3, R13, R14, R7, R8), since in mid-life the battery voltage (3.6-4.0V) will be lower than USB, hence the power source will default to USB. However, this has the disadvantage of slightly reducing battery life, since fresh batteries will continue to power the camera when connected to USB.

3.9 Using two 1.5V batteries (not evaluated)

This would require a DC-DC switcher to supply approximately 4.0-5.0v to the PFET Q8 (if fitted), or to the diode D1. But note that because the STV0680B and SDRAM are always powered in Standby Mode/PC Suspend Mode, this type of supply is only possible if a DC-DC switcher can be sourced which has a very low self current consumption (i.e. very good switcher efficiency even at low loads, e.g. load of 300µA). Please contact ST for advice.

3.10 Using a 9v Battery

Using a 9v battery should be possible if the following rules are adhered to:

1. Reference should be made to Figure 18 on page 46, which shows the differences in power supply circuit to the standard Reference Design.
2. A 5v Voltage regulator U10 with low Quiescent current is required, to keep the input voltage to the sensor regulator within safe limits (it cannot work direct from a 9v battery). A suitable Torex part has been suggested which includes a Chip Enable pin, however an alternate implementation could use a Voltage Regulator without a chip enable pin, plus an additional Bipolar and FET (as per Figure 14) to disable the battery when USB is connected.
3. Observe the value of Low battery sense resistors R10 and R11, the example shown (R10 = 1M, R11 = 220k) assumes that the battery will lose charge rapidly once 6.75v is reached for a PP3 cell, hence this could be a suitable cut-off point. With six AAA or AA cells, the design could be used but may require a change to R10 and R11 (for low battery detection) since the cutoff point at which the battery begins to lose charge rapidly may be different from PP3.
4. For all other aspects of the camera design, no changes are required.

Any battery life example calculations shown elsewhere in this reference design are dependant on the battery voltage and type, and are hence not applicable for a 9v battery.

<u>Note</u>: Only limited evaluation work has been done to prove that the implementation shown can work under all circumstances.

3.11 Other power supply considerations

- Ferrites near the USB connector may be required for EMC compliance

7.2 STV0680B pinout diagram

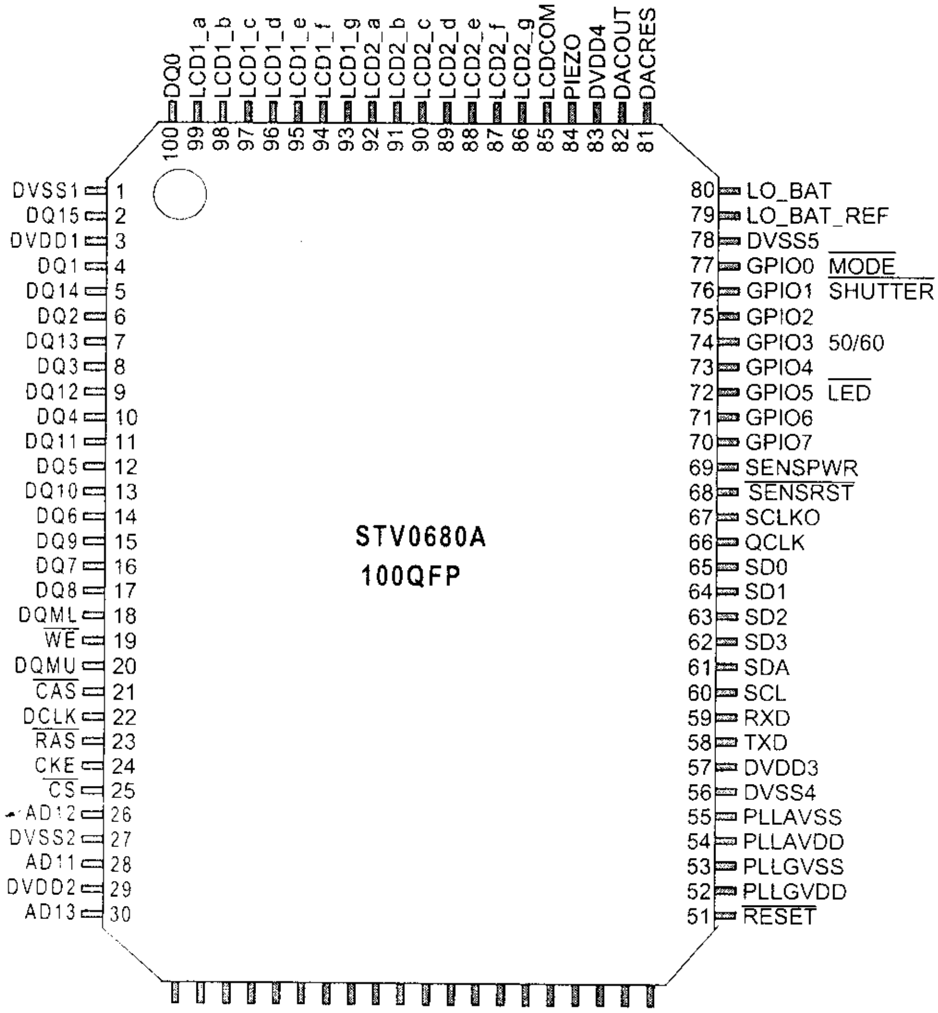


Figure 7 : STV0680B pinout in 100QFP package