Capacitive touch Basics

Sensor and Electrode construction

A touchscreen is usually constructed from a number of transparent electrodes, typically on a glass or film substrate. Electrodes are normally formed by etching a material called Indium Tin Oxide (ITO) which is high optical clarity and varying sheet resistance. The ITO is etched to form X strip and Y strip shown in the following diagram. The adjacent X/Y nodes form the mutual capacitive sensors.

Thicker ITO yields lower levels of resistance (perhaps tens to hundreds of ohms/square) at the expense of reduced optical clarity. Lower levels of resistance are generally more compatible with capacitive sensing. Thinner ITO leads to higher levels of resistance (perhaps hundreds to thousands of ohms/square) with some of the best optical characteristics.

Scanning Sequence

GSL168X supports up to 16 scanning channel and 10 sensing channels. The scanning channels are scanned in sequence. However, the scan order is fully programmable. The sensing channels are full parallelism. The channels are scanned by measuring capacitive changes at the intersections formed between X0 and Y0 – Yn, then the intersections between X1 and Y0 – Yn, and so on, until all X and Y combinations have been measured.

GSL168X can be configured in various ways, it is possible to disable some scanning or sensing channels so that they are not scanned at all. This can be used to improve overall scanning time. Although the sensing channels are parallel, the data order in the memory of each channel is fully programmable. This provide the maximum flexibility to the FPC or PCB design. User can program the scanning order or sensing data order through the Silead Ctouch Configure Suite or update the GSL168X configuration file directly.

Touchscreen sensitivity

Sensitivity of touchscreens can vary across the extents of the electrode pattern due to natural differences in the parasitic of the interconnections, control chip, and so on. An important factor in the uniformity of sensitivity is the electrode design itself. It is a natural consequence of a touch screen pattern that the edges form a discontinuity and hence tend to have a different sensitivity. The electrodes at the far edges do not have a neighboring electrode on one side and this affects the electric field distribution in that region. GSL168X auto compensate the sensitivity inconsistence for the whole touchscreen.

Detail Operation

Power Up and Reset

GSL 168X takes a single power supply ranging from 2.6v~3.3v. There is an internal Power-on Reset (POR) in the device. After power-up, the device takes 5 ms before it is ready to work. In order to effect a proper POR Vdd must drop to below 1.6V.

After the chip experiences a Power-on-reset, it asserts the IRQ line to signal to the host that a message is available. The reset flag is set in the Message Processor object(refer to GSL168X Application notes for details) to indicate to the host that it has just completed a reset cycle. This bit can be used by the host to detect any unexpected power breakout events and so allow it to take any necessary corrective actions, such as reconfiguration.

A software reset command can be used to reset the chip (refer to the GSL168X Application notes). A software reset takes ~1 ms. The reset event caused by software reset or RESET pin will not trigger the Power-on-reset message to host.

Calibration

Calibration is the process by which the sensor chip assesses the background capacitance on each channel. Channels are only calibrated on power-up and when:

-> the channel is held in detect for longer than the Touch Automatic Calibration setting .
-> the signal delta on a channel is at least the touch threshold in the anti-touch direction, while no other touches are present on the channel matrix .
-> the user issues a recalibrate command .

Communication

Communications Protocol

The GSL168X uses an I2C-compatible interface for communication. The device is not designed to be polled, as it only presents data packets when internal changes have occurred. The IRQ line going active signifies that a new data packet is available.

I2C-compatible Addresses

The GSL168X supports a single I2C-compatible device addresses, 0x40. It is shifted left to form the SLA+W or SLA+R address when transmitted over the I2C-compatible interface, as shown in table below.

Writing to the Device

A WRITE cycle to the device consists of a START condition followed by the I2C-compatible address of the device (SLA+W). The next byte is the address of the location into which the writing starts.

Subsequent bytes in a multibyte transfer – the actual data – are written to the location of the address pointer, location of the address pointer +1, location of the address pointer + 2, and so on.

The WRITE operation ends with the STOP condition on the I2C-compatible bus. A new WRITE cycle involves sending another address pointer. Note that the WRITE cycle must end with a STOP condition; the GSL168X may not respond correctly if a cycle is terminated by a new START condition.

Reading from the Device

To read from the device, usually two I2C-compatible bus activities take place: the first is an I2Ccompatible write to set the address pointer, and the second is the actual I2C-compatible read to receive the data. The address pointer returns to its starting value when the READ cycle’s STOP condition is detected.

It is not necessary to set the address pointer before every read. The address pointer is updated automatically after every read operation so, if the reads occur in order, the address pointer will be correct.

The WRITE and READ cycles consist of a START condition followed by the I2C-ompatible address of the device (SLA+W or SLA+R respectively). Each cycle must end with a STOP condition; the GSL168X may not respond correctly if a cycle is terminated by a new START condition.

SDA, SCL

The I2C-compatible bus transmits data and clock with SDA and SCL, respectively. These are open-drain; that is, I2C-compatible master and slave devices can only drive these

lines low or leave them open. The termination resistors (Rp) pull the line up to Vdd if no I2C-compatible device is pulling it down.

The termination resistors commonly range from 1 k ohm to 10 k ohm and should be chosen so that the rise times on SDA and SCL meet the I2C compatible specifications.

IRQ

The IRQ pin is an active-high output pin that is used to alert the host that a new message is available. This provides the host with an interruptstyle interface with the potential for fast response times and reduces the need for wasteful I2C-compatible communications. The host should ALWAYS use the IRQ pin as an indication that a message is available to read;

The host should not read the Message at any other time (for example, continually poll the Message). As an error checking mechanism, if the chip has to read when the IRQ line is not asserted, a double read is recommended and the consistent reading results can be used as an indication that no co-occurrence of read and update of message happen.

Operation mode

The GSL168X operates at one shutdown mode and three running modes.

Shutdown mode

T
he device has a SHUTDOWN pin that, when pull low, will put GSL168X in deepsleep mode, in
which the device consume the least power. After the SHUTDOWN pin is disserted, the device is wake up
from the deepsleep mode and ready to take the START command from host to get into the running
modes.
It is recommended to connect the SHUTDOWN pin to a GPIO of host controller. The host can put
GSL168X into deepsleep mode when the touch screen is not needed to be running.

Running modes

When GSL168X is active, it operates on a combination of three fixed cycle times. There is one acquisition per cycle. When no channels are touched, the cycle time is given by the GREEN_SCANDELAY setting in the device configure file. Every cycle, one acquisition is made and the device then sleeps for the remainder of the cycle.

If a channel is touched, the device turn to active mode and the cycle changes to the ACTIVE_SCANDELAY setting for a faster response. It remains in this active mode until the ACTIVE_TIMEOUT has expired after the last touch, the device enters the low speed scan mode and the cycle changes to LOW_SCANDELAY setting for a slower response. If a channel is touched, the device will return to the active mode, otherwise, it stays at low speed scan mode until LOW_TIMEOUT has expired and then enter the green mode in which the device monitor the touch panel at the much slower speed.

The touch reporting rate of the active, low speed and green modes, timeout to transit from one mode to the others all are configurable through Silead Ctouch Configure Suiteor GSL168X configuration file.

The default frame reporting rate of the active, low speed and green mode are, 60, 30

and 5 respectively. The maximum allowed reporting rate is 200 frames/s and the minimum allowed reporting rate is 0.5 frames/s. In each frames, multi-touch can be reported.