SH1475
Single-Axis Capacitive Touch Sensor Controller

HID & SYSTEM MANAGEMENT PRODUCTS — PRELIMINARY

DESCRIPTION

The SH1475 single-axis capacitive touch sensor controller is a cost-effective, single-dimension capacitive position analyzer with a full-duplex SPI® interface. The SH1475 is ideal for handheld devices such as MP3 players.

The SH1475 uses an advanced algorithm for enhanced motion control interfacing PCB-based capacitive sensor. The SH1475 includes a signal conditioning circuit for a low cost, simple and real estate-saving implementation. Just a few additional low-tolerance external components are needed for a complete solution.

Typically consuming about 1 µA in the standby state, the SH1475 is ideal for battery-operated systems.

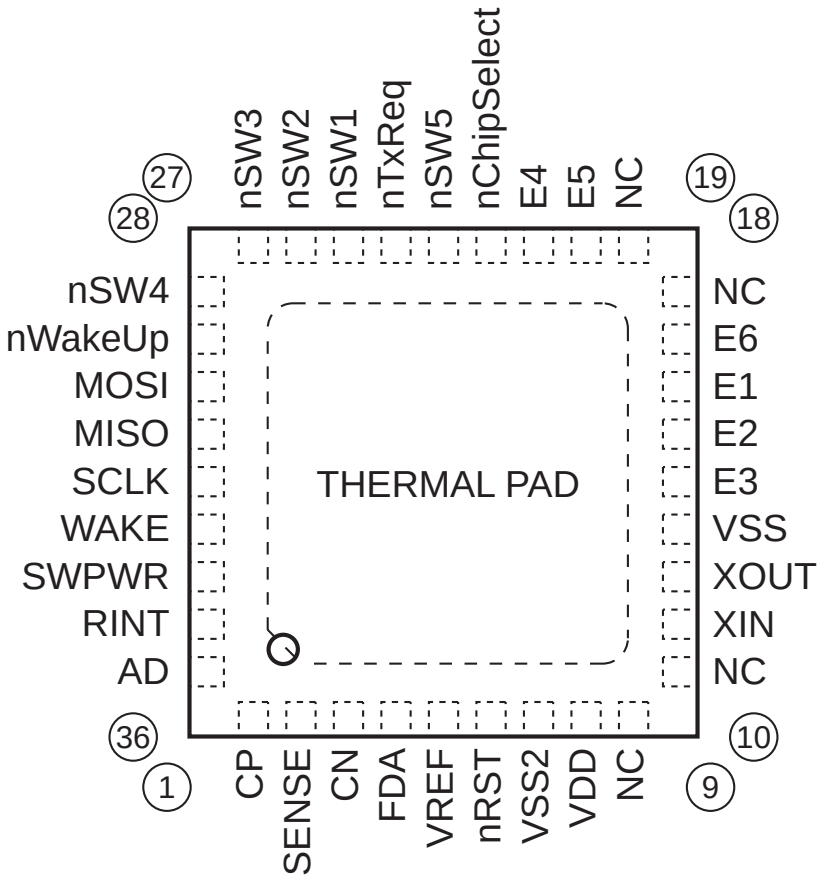
FEATURES

- Full-duplex SPI Interface
- PCB-based capacitive sensor
- Five switches
- 2.7 V – 5.5 V
- Low power consumption: 1 µA in standby state (typical)
- Royalty-free and cost-effective
- Customization available
- Small 6 mm x 6 mm 36-lead MLPQ package

APPLICATIONS

- Portable media players
- Portable media centers
- Instruments
- Cell phones

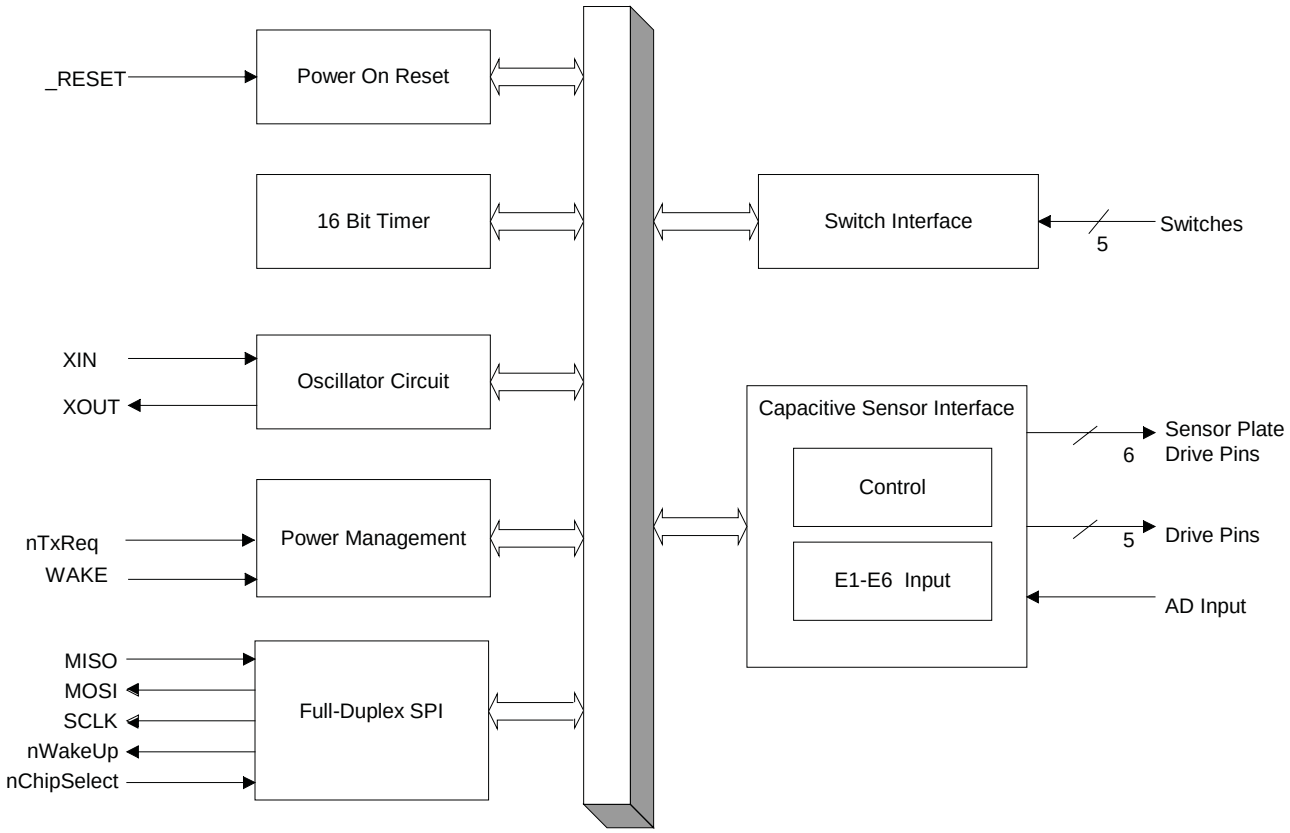
PIN ASSIGNMENTS



ORDERING CODE

Package Options	Pitch	TA= -20° C to +85° C
36-pin plastic MLPQ (lead free) Fully RoHS & WEEE compliant	0.5 mm	SH1475IMLTRT

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

The SH1475 consists functionally of several major sections (see the block diagram on the previous page). These include the capacitive sensor interface, the switch interface, the 16-bit timer, the oscillator circuit, the full-duplex SPI communication port, and the power management. All sections communicate with each other and operate concurrently.

OSCILLATOR

The SH1475 has a built-in oscillator circuit intended to work with an external 4.00 MHz ceramic resonator with built-in load capacitors, or an external 4.00 MHz crystal.

SWITCHES

The SH1475 samples five switches and reports their state to the host system. The five switches can be mapped to MP3 player operation buttons as follows (for example).

SW1 - Select

SW2 - Next

SW3 - Previous

SW4 - Play

SW5 - Menu

PIN DEFINITIONS

Mnemonic	Pin	Type	Name and Function
Thermal pad	–		Thermal pad: connect to ground
Power			
VDD	8	P	Power supply: 2.4 V – 5.5 V
VSS	13	P	Ground
VSS2	7	P	Connected to VSS
VREF	5	I	Analog voltage reference
Reset			
nRST	6	I	Reset
Oscillators			
XIN	11	I	Oscillator input
XOUT	12	O	Oscillator output
SPI			
MOSI	30	O	Data output (master out slave in); tri-stated (floated) when nChipSelect is high
MISO	31	I	Data input (master in slave out); ignored when nChipSelect is high
SCLK	32	O	SPI clock output; tri-stated (floated) when nChipSelect is high
nChipSelect	22	I	Chip Select: Active-low input from the host; if high, SH1475 transmission is disabled; if low, SH1475 transmission is enabled
nWakeUp	29	O	nWakeUp: Active-low output from the SH1475; asserted (low) for any transmission of the SH1475; clocking does not start until nChipSelect is low
Switches			
nSW1-nSW4	25-28	I/O	Switch 1–4 input
nSW5	23	I/O	Switch 5 input
Capacitive Sensor			
SWPWR	34	I/O	Switched power driver
RINT	35	I/O	Integration drive
AD	36	I/O	AD input
CP	1	I/O	Sample capacitor plus drive
CN	3	I/O	Sample capacitor minus drive
FDA	4	I/O	Fine D/A Adjustment
SENSE	2	I/O	Common sense signal
E1-E3	16-14	I/O	Sensor plate 1–3 drive
E4-E5	21-20	I/O	Sensor Plate 4–5 drive
E6	17	I/O	Sensor Plate 6 drive
Power management			
nTxReq	24	I	Transmit request: Active-low input from the host; asserted (low) when host needs to send
WAKE	33	O	Periodic wake-up enable output
No connect			
NC	9-10, 18-19		No connect

Note: A pin/lead mnemonic beginning with lower-case “n” denotes an active low signal.
Pin Types Legend: P=Power; I=Input; O=Output; I/O=Input or Output;

CAPACITIVE SIGNAL CONDITIONING CIRCUIT

The SH1475 interfaces with a PCB-based capacitive sensor with six separate sensor plates and one common sensing line. Each separate sensor plate and the common sensing line are coupled via a capacitor. The customer may choose to use individual capacitors (designated C10 through C15 on the application circuit), or the coupling capacitors could be built-into the PCB, by providing a common sense plate under the sensor plates.

The shape of the sensing area could be readily modified to accommodate the design requirements of the customer, and may include (but not limited to) the linear, rectangular, circular, spiral, smooth wave or zigzag. The sensing area may also be applied over a 3-dimentional object, such as a semi-sphere.

Typically, all the sensor electrodes are isolated from the outside of the customer's device by a layer of galvanically isolating non-conductive dielectric (plastic). It could be a sheet of Mylar® with adhesive backing, or the galvanic barrier could be built-into the customer's device enclosure.

The apparent capacitance of the sensor plate to ground increases when a finger approaches a sensor plate. The capacitance increase is directly proportional to the overlap area between the tip of the finger and the sensor plate, and it is inversely proportional to the distance between the finger and the sensor plate. By looking at change of capacitance on all six electrodes, it is possible to extrapolate the actual position of the finger with high accuracy and resolution.

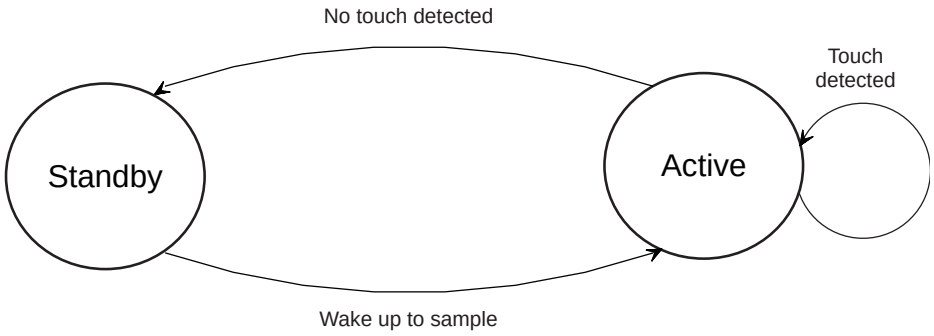
The SH1475 measures the changes of capacitance for each of the sensor plates, one by one. Each sensor plate is repeatedly charged, and the charge is transferred to one of two sampling capacitors, the so-called positive and negative sample capacitors. The sampling algorithm is arranged in such a way that the resulting voltage on the series-connected sampling capacitors is proportional to the change of capacitance for the sensor plate, while any noise coupled from the outside is greatly reduced.

The actual capacitance-change signal is quite small, typically under 1 mV Full Scale. The signal conditioning circuit balances and amplifies the incoming signals for digitizing by the built-in A/D converter.

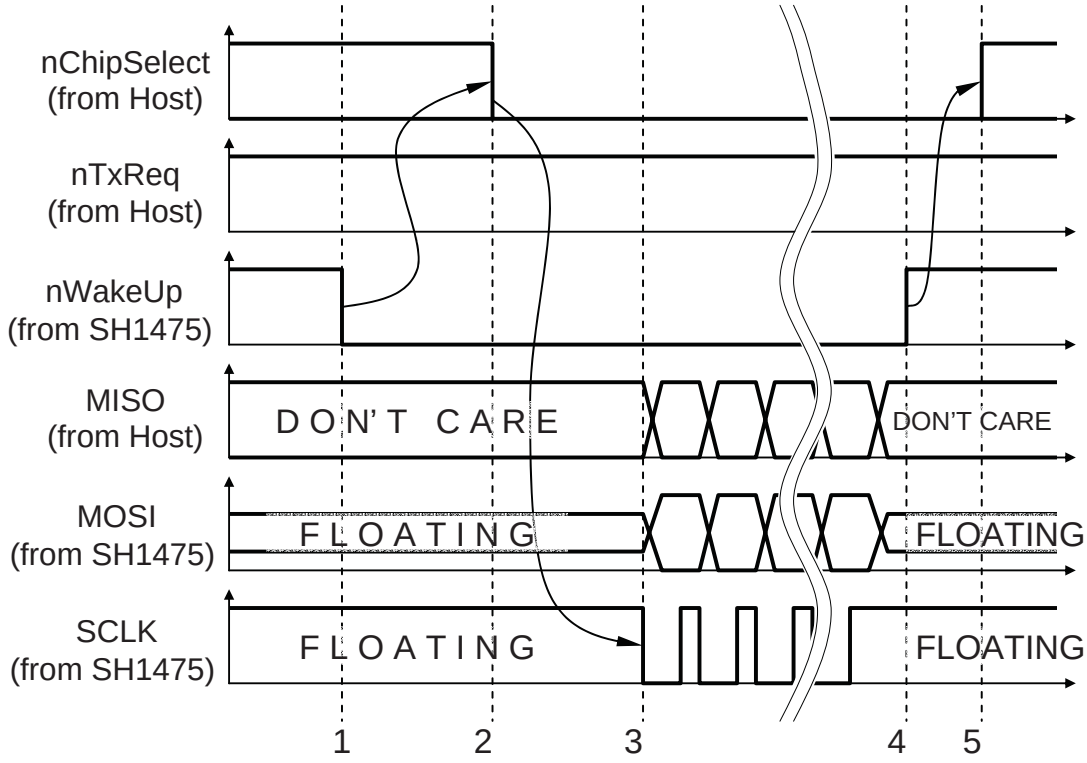
The SH1475 does one measurement for each of the six sensor plates to get the capacitance changes. The SH1475 derives the touch/proximity and position information from these six measurements.

SELF-POWER MANAGEMENT™

The SH1475 implements a comprehensive power algorithm called Self-Power Management™ to maximize power savings. The SH1475 works in two modes: active and standby. When the SH1475 is in standby mode, it transitions to active state and samples the capacitive sensor and switches every 150 ms; if no touch is detected, it returns to standby state immediately. When the SH1475 detects a touch on the capacitive sensor, or a press on any of the switches, it stays in active mode and reduces the sampling period to 15 ms. Once both the touch sensor and the switches are released, the SH1475 goes back to standby mode. The transition between active mode and standby mode is automatic.



SH1475 TO HOST COMMUNICATION



Host is awake or sleeping, SH1475 has data to send

1. SH1475 asserts nWakeUp.

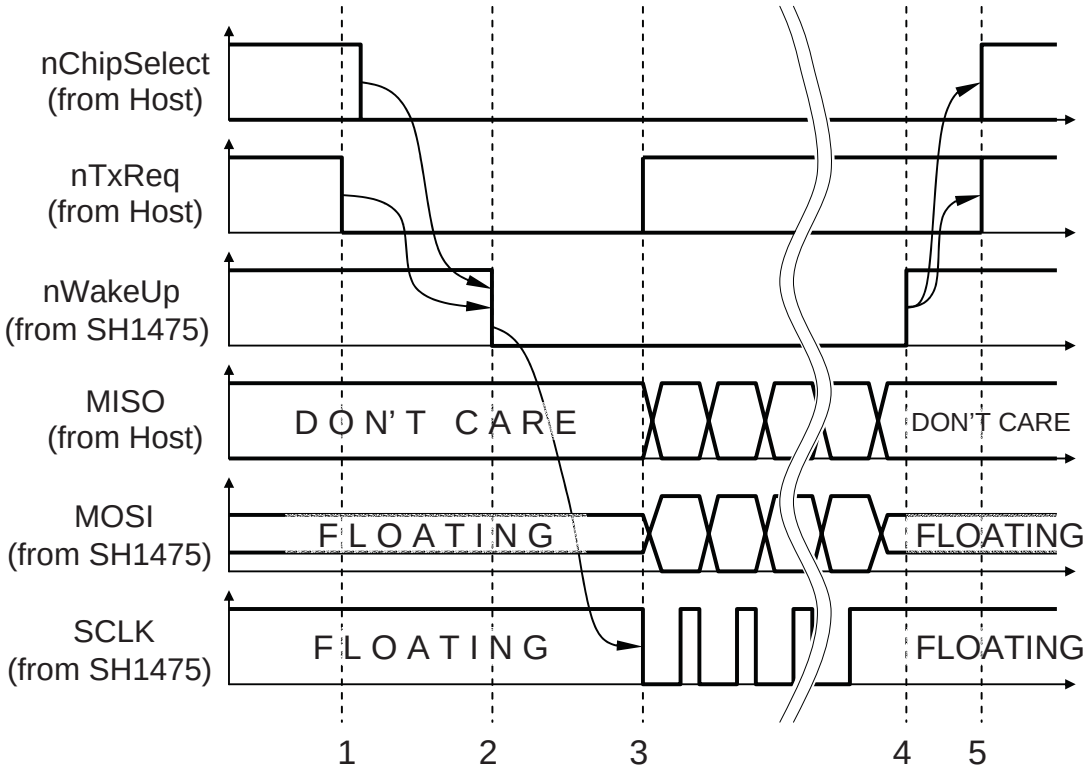
2. Host asserts nChipSelect. If nChipSelect is low already, it will stay low.

3. SH1475 drives the MOSI and SCLK lines and sends the packet. Host may send a complete command packet, or Host must keep MISO line static (or at least NOT send command packet sync pattern in the first byte).

4. SH1475 floats the MOSI and SCLK lines and de-asserts nWakeUp.

5. Host may de-assert nChipSelect and go to sleep.

HOST TO SH1475 COMMUNICATION



Host has data to send, SH1475 is awake or sleeping

1. Host asserts nTxReq, then nChipSelect (if high).

2. SH1475 asserts nWakeUp.

3. SH1475 drives the MOSI and SCLK lines and receives the packet. A complete packet of data from SH1475 may also be transmitted at this time. Host may de-assert nTxReq.

4. SH1475 floats the MOSI and SCLK lines and de-asserts nWakeUp.

5. Host must de-assert nTxReq and may de-assert nChipSelect.

Only one packet is received for each assertion of the nTxReq line.

COMMUNICATION PACKET

Line #	Name	Data Packet																							
		Byte 1										Byte 2										Byte 3			
		b23 [b]	b2 2	b2 1	b2 0	b1 9	b1 8	b1 7	b1 6			b1 5	b1 4	b1 3	b1 2	b1 1	b1 0	b1 9	b1 8	b7	b6	b5	b4	b3	b2	b1	b0
Data / Reports from SH1475 to Host																									
1	Motion Report	1	0	0	1	Don't Care [c]			SW5	SW4	SW3	SW2	SW1	4-bit Pressure Data [a]		8-bit Position Data									
2	Reset Report	1	1	1	1	0	0	0	0	Don't Care [c]										Don't Care [c]					
3	Register Data	1	0	1	0	Don't Care [c]			Page	8-bit Register Number										8-bit Register Data					
Commands / Data from Host to SH1475																									
4	Reset Request	1	1	1	1	0	0	0	0	Don't Care [c]										Don't Care [c]					
5	Register Read	1	0	1	0	Don't Care [c]			Page	8-bit Register Number										Don't Care [c]					
6	Register Write	1	0	1	1	Don't Care [c]			Page	8-bit Register Number										8-bit Register Data					

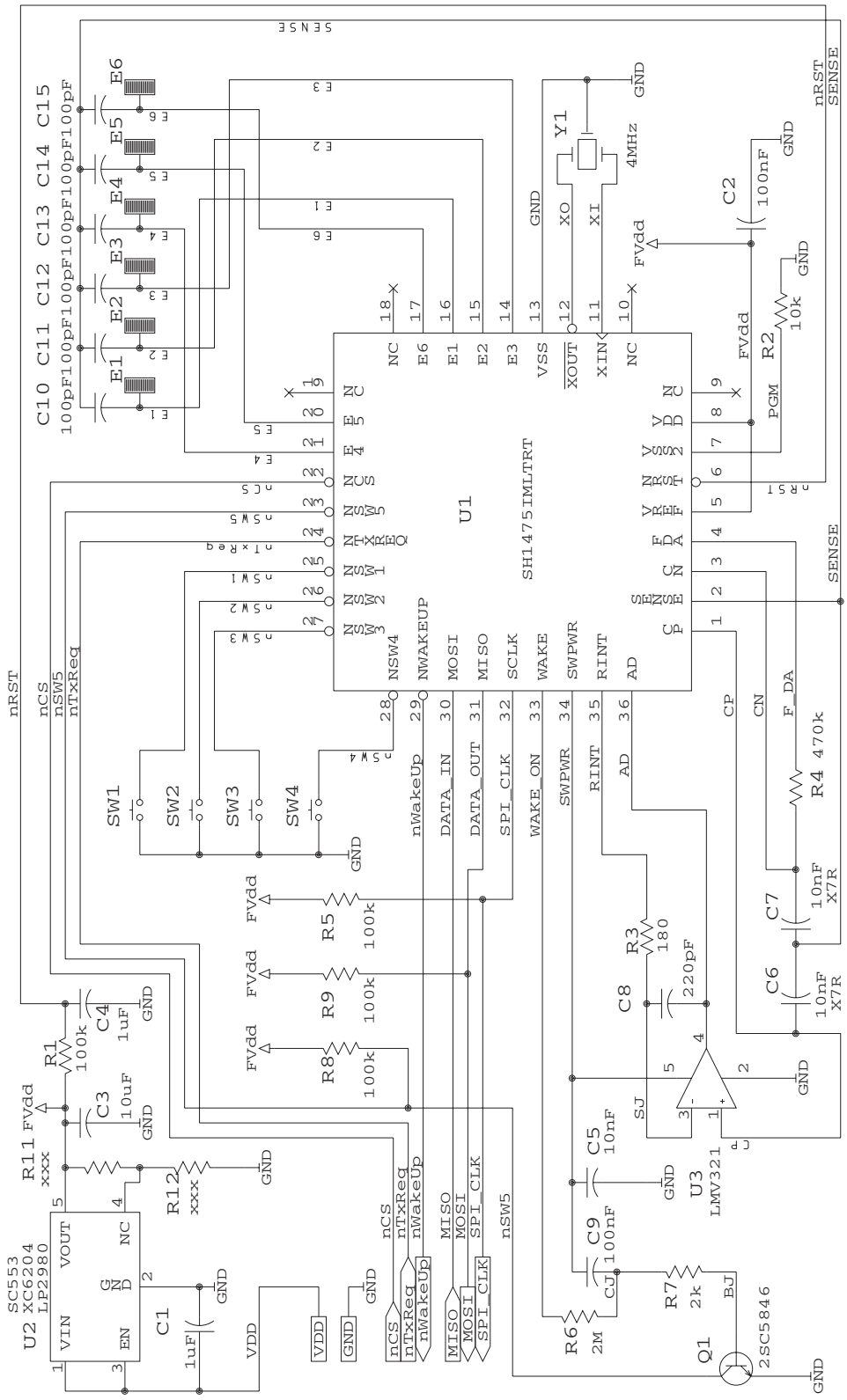
COMMUNICATION PACKET NOTES

a. Pressure Data = 0 implies "no touch."

b. Byte 1 (b23) is transmitted and received first (e.g. the order of transmission is b23-through-b0).

c. It is suggested for the "Don't Care" bits to transmit a pattern without many transitions in order to reduce power consumption and EMI.

SH1475 APPLICATION CIRCUIT



ELECTRICAL SPECIFICATIONS

Absolute maximum ratings

Rating	Symbol	Value	Unit
Supply voltage	V_{DD}	-0.3 to 5.5	V
Input voltage	V_{IN}	V_{SS} - 0.3 to V_{DD} + 0.3	V
Current drain per pin (not including V_{SS} or V_{DD})	I	20	mA
Operating temperature SH1475	T_A	T_{LOW} to T_{HIGH} -20 to +85	°C
Storage temperature range	T_{STG}	-40 to +125	°C
ESD rating (human body model)	V_{ESD}	2.0	kV

DC electrical characteristics (temperature range = T_{LOW} to T_{HIGH} unless otherwise noted)

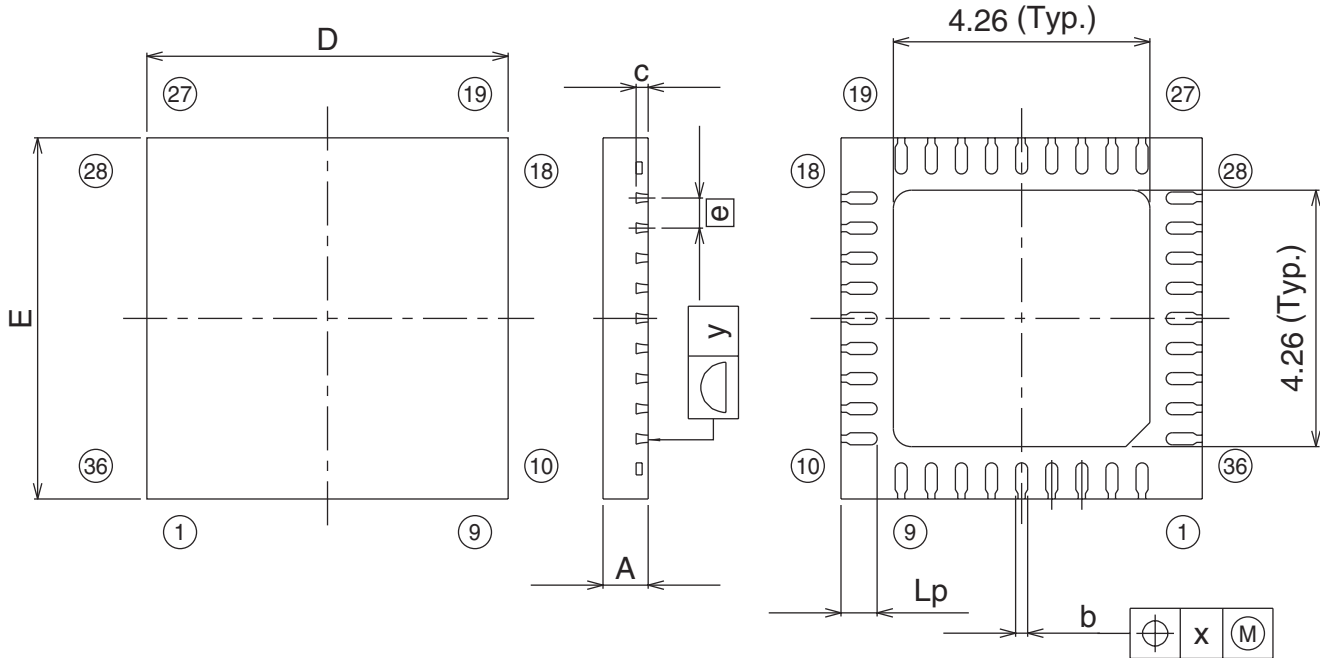
Characteristic	Symbol	Min	Typ	Max	Unit
Supply voltage		2.4	3.3	5.5	V
Output voltage (10 µA load)	V_{OH}	V_{DD} – 0.1			V
	V_{OL}			0.1	
Input high voltage	V_{IH}	0.8 x V_{DD}		V_{DD}	V
Input low voltage	V_{IL}	V_{SS}		0.2 x V_{DD}	V
Input current	I_{IN}			+/- 10	µA
Supply current (V_{DD}=3.3 V_{DC} ± 10%, V_{SS} = 0)					
■ Active (touch)	I_{DD}		1	2	mA
■ Active (no touch)*	I_{DD}		50	100	µA
■ Standby	I_{DD}		1	10	µA
Acceptable ripple	V_{P-P}			TBD	V

Control timing (V_{DD} = 2.4 – 5.5 V_{DC}, V_{SS} = 0 V_{DC}, Temperature range = T_{LOW} to T_{HIGH} unless otherwise noted)

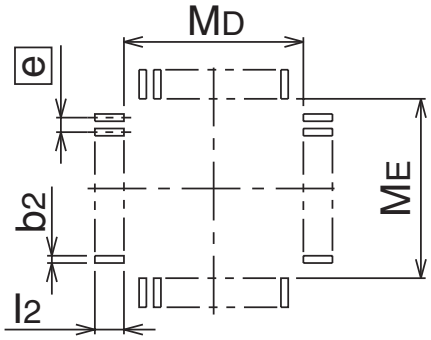
Characteristic	Symbol	Min	Typ	Max	Unit
Frequency of operation					
■ Ceramic resonator option	f_{OSC}		4.0		MHz
■ External clock option	f_{OSC}		4.0		MHz

*Average of active and standby current when no touch is taking place.

MECHANICAL INFORMATION FOR THE MLP-36 PACKAGE



Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	Ð	Ð	0.8
b	0.15	0.2	0.25
c	Ð	0.2	Ð
D	5.9	6.0	6.1
E	5.9	6.0	6.1
e	Ð	0.5	Ð
Lp	0.5	0.6	0.7
x	Ð	Ð	0.05
y	Ð	Ð	0.05
b_2	Ð	0.3	Ð
l_2	0.7	Ð	Ð
M_D	Ð	4.8	Ð
M_E	Ð	4.8	Ð



Recommended Mount Pad

For sales information
and product literature,
contact:

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