SH1201 PixiPoint®
Advanced “Click-to-Select”
No-Drift™ Force Stick Encoder

HID & SYSTEM MANAGEMENT PRODUCTS, MOUSECODER® FAMILY

DESCRIPTION

The SH1201 PixiPoint® mouse encoder is a cost-effective, high-functionality IC that interfaces a force-stick sensor to a PS/2 or serial port. Ideal for laptop or palmtop use, the low-power PixiPoint uses an advanced algorithm for enhanced motion control. The IC can be configured as a standard 3-button mouse or as a wheel mouse. The IC provides an extra port for hot-plug connection of an external PS/2 mouse, including one with wheel function. The embedded sensor and the external device can operate concurrently.

The PixiPoint includes a signal conditioning circuit for a low cost, simple and real estate-saving implementation. Just a few low-tolerance external components are needed.

Typically consuming less than 3.3 mA, the PixiPoint is ideal for battery-operated systems.

PS/2 communication is bidirectional at 10 Kbps. The PixiPoint returns up to 100 mouse reports per second, and is compatible with the standard three-button mouse protocol and the standard wheel mouse protocols. It implements all commands from and to the system (as defined in the IBM PS/2 mouse communication protocol).

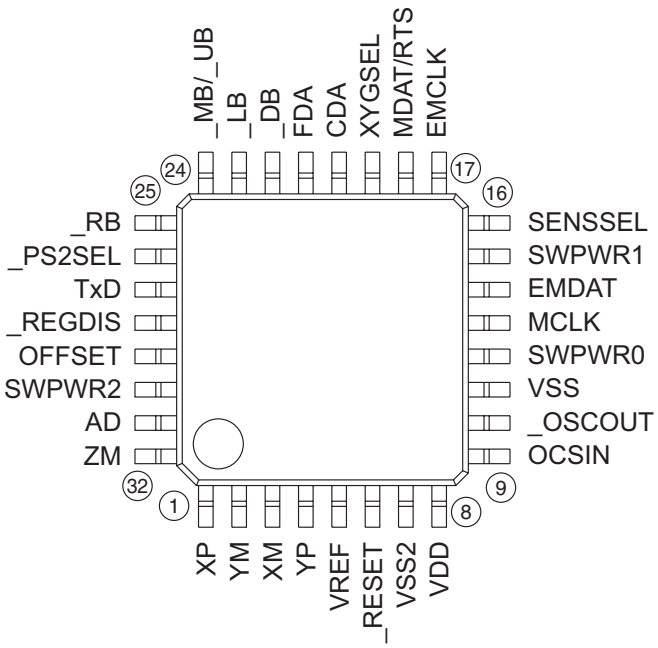
FEATURES

- Advanced motion control algorithm provides accurate cursor control
- Can be configured for PS/2 or RS232 serial communication with the host
- Can be configured as a standard 3-button mouse or a wheel mouse
- Complies with the Microsoft® *Plug and Play External COM Device* specification
- Click (select), double-click (execute), and slow drag are implemented in the IC – no special driver support is required
- Provides built-in profiles to interface popular force-stick sensors from several manufacturers
- Supports hot-plug connection of a standard external PS/2 mouse, with or without wheel function
- Works with standard Windows® mouse drivers
- Compatible with IBM force stick protocol
- CleanStop™ feature means cursor stops with precision
- In PS/2 mode, supports all standard PS/2 commands
- Low power consumption: 3.3 mA (typical)
- 2.7 V–5.5 V operation over extended temperature range

APPLICATIONS

- Notebooks/laptops
- Handhelds
- Keyboards
- Instrumentation

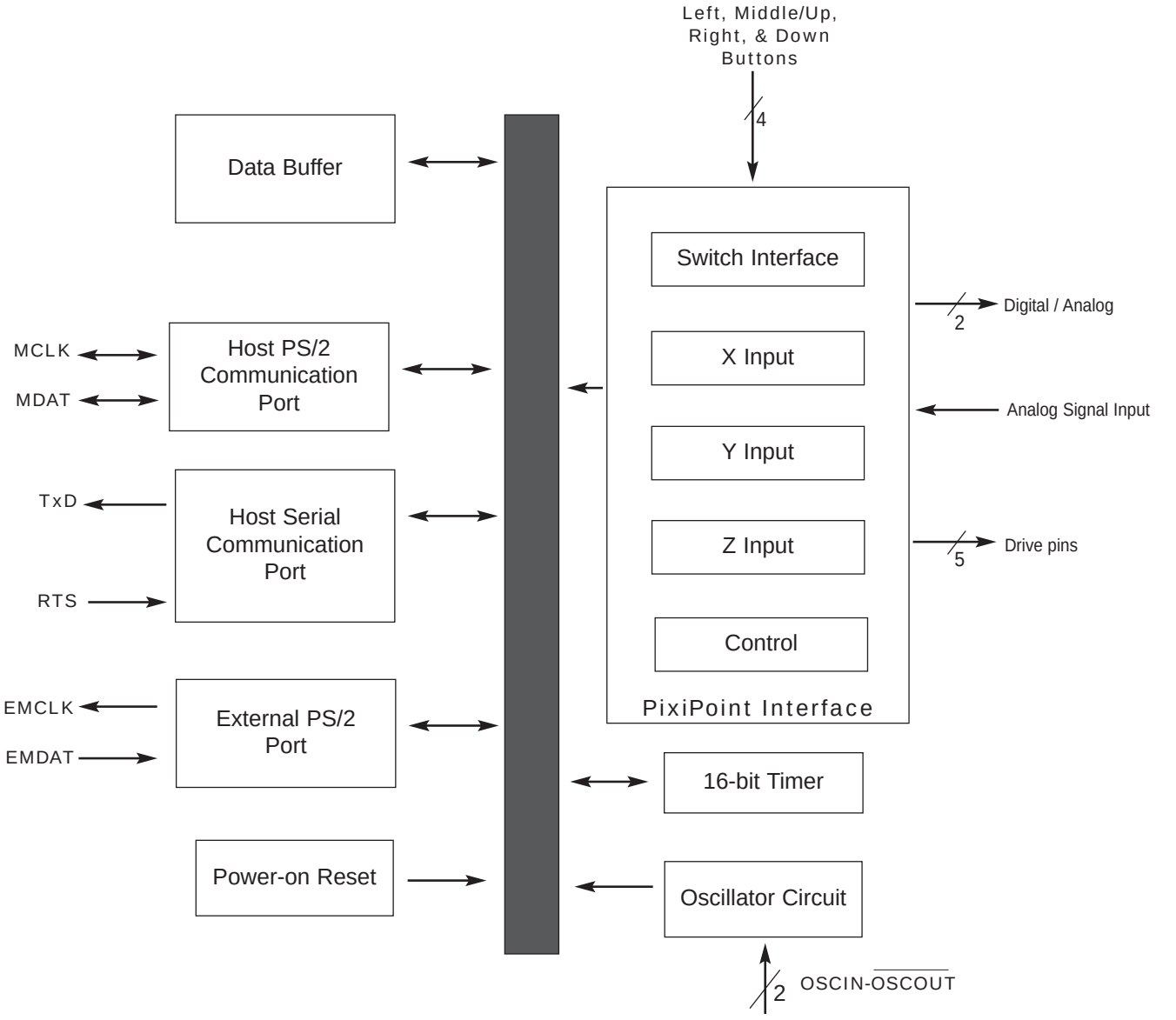
PIN ASSIGNMENTS



ORDERING CODE

Package	Pitch	TA = -20°C – +85°C
32-pin LQFP	0.8 mm	SH2101-FG
Evaluation kit	EVK-SH1201	

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

The SH1201 consists functionally of several major sections (see the block diagram on the previous page). These include the PixiPoint interface, the 16-bit timer, the oscillator circuit, the host PS/2 communication port, the host serial communication port, and the external PS/2 port. All sections communicate with each other and operate concurrently.

SENSOR SUPPORT

The SH1201 has built-in profiles to interface with several sensors, some of which are listed here. A profile is selected by tying the SENSSEL line (pin 16) to the indicated line.

CTS 106 - floating
CTS 109 - ground
CTS 105 - XP (pin 1)
K-Tech 3.2 - YM (pin 2)

SENSOR Z-AXIS SUPPORT

The SH1201 has built-in Z-axis functionality to recognize click and double-click on the force stick itself.

Z-axis functionality depends on an appropriate resistor Rz at the sensor input (R4 in the mode schematics, R4, R12, or R11 in the evaluation board schematic in this data sheet). This resistor value is one half the resistance of one strain gauge of the sensor. Omitting this resistor and leaving this connection open disables Z-axis functionality. Examples of Rz values:

CTS 106 - 1.6 KΩ
CTS 109 - 1.24 KΩ
CTS 105 - 1.6 KΩ
K-Tech 3.2 - 1.6 KΩ

PIN DEFINITIONS

Mnemonic	Pin #	Type	Name and Function
V_{DD}	8	P	Power supply: 2.7 V–5.5 V (depends on host interface mode)
V_{SS}	11	P	Ground
$V_{SS}2$	7	P	Ground
_RESET	6	I	Reset: apply 0 V for proper start-up
_OSCOUT	10	O	Oscillator output: open for external clock input or one side of the ceramic resonator with built-in load capacitors
OSCIN	9	I	Oscillator input: external clock input or one side of the ceramic resonator with built-in load capacitors
MCLK	13	I/O (nd)	Host PS/2 clock
MDAT/RTS	18	I/O (nd)	Host PS/2 data / serial request-to-send input
EMCLK	17	I/O (nd)	External mouse clock: PS/2 clock signal from external mouse
EMDAT	14	I/O (nd)	External mouse data: PS/2 data signal from external mouse
TxD	27	O	Serial transmit to host: idle high
_DB	22	I/O (nd)	Down button: active low, strobed sampling
_LB	23	I/O (nd)	Left button: active low, strobed sampling
_MB/_UB	24	I/O (nd)	Middle/up button: active low, strobed sampling
_RB	25	I/O (nd)	Right button: active low, strobed sampling
AD	31	AI	Analog to digital converter input
SENSSEL	16	I/O (nd)	Sensor select pin: normally left floating
_REGDIS	28	I/O (nd)	Regulator disable/enable (low = disable)
VREF	5	AI	Reference voltage for built-in A/D; internal reference only
XM	3	I/O	X minus drive pin
XP	1	I/O	X plus drive pin
YM	2	I/O	Y minus drive pin
YP	4	I/O	Y plus drive pin
ZM	32	I/O	Z minus drive pin
XYGSEL	19	I	XY gain 100% floating, 75% tied to ground, 50% tied to SWPWR2, 125% tied to REGDIS
CDA	20	O	Coarse digital-to-analog
FDA	21	O	Fine digital-to-analog
_PS2SEL	26	I	Interface select: tie to ground for PS/2 host, tie to power (Vcc) for serial host
OFFSET	29	I/O	Offset: resets the offset circuit during inactivity
SWPWR0	12	I/O	Switched power driver
SWPWR1	15	I/O	Switched power driver: connect to SPWR0
SWPWR2	30	I/O	Switched power driver: connect to SPWR0

Note: An underscore before a pin mnemonic denotes an active low signal.
Pin types legend: P = power, AI = analog input; I = input; O = output; I/O = input or output; I/O (nd) = input or output with N-channel open drain driver

HOST INTERFACE

The PixiPoint communicates with the host system using high-speed PS/2, low-speed PS/2, or serial. The state of the interface select pin (PS2SEL, pin 26) determines which interface is used. If the pin is tied to ground, high-speed PS/2 is used; if it is tied to SWPWR2 (pin 30), low-speed PS/2 is used; if it is tied to power (Vcc), serial is used.

EXTERNAL PS/2 SPEED

High-speed PS/2 host interface
4 V–5.5 V power supply
external PS/2 port speed:
100 reports/second maximum

Low-speed PS/2 host interface
2.7 V–5.5 V power supply
external PS/2 port speed:
60 reports/second maximum

Serial host interface
2.7 V–5.5 V power supply
external PS/2 port speed:
60 reports/second maximum

Note: Embedded (internal) pointer speed is 100 reports/second maximum for all interface types

BUILT-IN FEATURES

Tap — Select.

Double Tap — Execute.

Press Hold — Drag.

EasyDrag™ — reduces the speed of the cursor when the user is dragging an object on the desktop, making it simple to accurately handle the object.

CleanStop™ — ensures that the cursor stops precisely.

POWER CONSUMPTION

The SH1201 typically consumes less than 3.3 mA. Low-power consumption makes it ideal for use in battery-operated systems.

SIGNAL CONDITIONING CIRCUIT

The PixiPoint interfaces with a sensor that has four strain gauges – one on each of its sides. If force is applied precisely in the X direction, it produces a change of resistance of only the two X gauges. Force in the Y direction causes changes only in the Y gauges. One of the pair of gauges increases, while the other decreases in resistance.

If the user presses on the sensor from the top (Z axis), all of the strain gauges decrease in resistance.

When the test current is passed through the gauges, these resistance changes are converted into voltage changes. These signals are very small, typically under 1 mV Full Scale.

The signal conditioning circuit balances and amplifies the incoming signals for digitizing by a built-in A/D converter.

Semtech's circuit can correct a significant imbalance between the gauges in each X and Y pair (± 12.5%), allowing relaxed manufacturing tolerances for the sensors and cabling. There is no performance degradation over the full operating temperature range, and no degradation for large temperature gradients between the paired gauges.

MOUSE EMULATION

The PixiPoint emulates either a standard 3-button mouse or a standard wheel mouse. The mouse type emulated depends on the state of the down button pin (DB, pin 22).

For standard 3-button mouse operation, leave DB floating.

For standard wheel mouse operation, if the host inteface is PS/2, tie DB to TxD (pin 27).

For standard wheel mouse operation, if the host inteface is serial, tie DB to MCLK (pin 13).

In 3-button mode, the left, right and middle buttons are implemented.

In wheel mode, the left, right, up, and down buttons are implemented; pressing up and down buttons together emulates a middle-button press.

SERIAL HARDWARE

The TxD and RTS lines are CMOS logic-level signals, suitable for direct connection to the pins of an UART. Interfacing via the RS-232 port requires the addition of an inverting driver and receiver. A simple one-transistor inverting driver and receiver may be used.

SERIAL COMMUNICATION

Communication through the serial port is uni-directional at a fixed speed of 1200 Baud, 7N1 protocol (7 data bits, 1 stop bit, no parity check).

The host can reset the device at any time by setting the RTS line high. When RTS is set low after a delay of at least 100 ms, the PixiPoint responds in one of two ways as shown below. Its response depends on its mode: wheel mode or 3-button mode, as determined by the state of the down button pin (DB, pin 22).

Wheel mode

When the PixiPoint is in wheel mode, and RTS is set low after a delay of at least 100 ms, the PixiPoint responds with the two identification characters “MZ” (0x4D, 0x5A); they are followed by a zero motion report consisting of the four bytes 0x40, 0x00, 0x00, 0x00, and then by the following plug-and-play string:

(vvSTH1201\\MOUSE\PNP0F0A\PIXIPOINTcc)

Note that vv represents a 2-byte binary plug-and-play version number, and cc is a 2-byte binary checksum. Except for those two binary fields, this plug-and-play string (including the parentheses) consists of ASCII characters with their codes reduced by 0x20. For further information, please refer to the *Plug and Play External COM Device Specification*, available from Microsoft. See the following web page (subject to change): http://www.microsoft.com/whdc/resources/respec/specs/pnpcom.mspx

3-button mode

When the PixiPoint is in 3-button mode, and RTS is set low after a delay of at least 100 ms, the PixiPoint responds with the two identification characters “M3” (0x4D, 0x33); they are followed by a zero motion report consisting of the four bytes 0x40, 0x00, 0x00, 0x00, and then by the following plug-and-play string:

(vvSTH1201\\MOUSE\PNP0F0A\PIXIPOINTcc)

Note that vv represents a 2-byte binary plug-and-play version number, and cc is a 2-byte binary checksum. Except for those two binary fields, this plug-and-play string (including the parentheses) consists of ASCII characters with their codes reduced by 0x20. For further information, please refer to the *Plug and Play External COM Device Specification*, available from Microsoft. See the following web page (subject to change): http://www.microsoft.com/whdc/resources/respec/specs/pnpcom.mspx

SERIAL DATA REPORTS

In wheel mode, data reports are always four bytes long.

In 3-button mode, data reports are four bytes long only if the middle button is depressed or changing state; otherwise, data reports are three bytes long.

A data report is sent if motion is detected, or if buttons are pressed or released. X and Y motion is reported relative to the last report sent, in a two's complement form with 8-bit resolution. Therefore, motion values can range from -128 to +127.

Z3-Z0 is Z-displacement (wheel value), a 4-bit two's complement value from -8 to +7.

Byte 1	
b0	X6
b1	X7: MSB of X Data
b2	Y6
b3	Y7: MSB of Y Data
b4	Right button status, 1 = depressed
b5	Left button status, 1 = depressed
b6	Always=1

Byte 2	
b0	X0: LSB of X data
b1	X1
b2	X2
b3	X3
b4	X4
b5	X5
b6	Always=0

Byte 3	
b0	Y0: LSB of Y data
b1	Y1
b2	Y2
b3	Y3
b4	Y4
b5	Y5
b6	Always=0

Byte 4 (wheel mode)	
b0	Z0: LSB of Z data
b1	Z1
b2	Z2
b3	Z3: MSB of Z data
b4	Middle button status; 1=depressed
b5	Always=0
b6	Always=0
b6	Always=0

Byte 4 (3-button mode, only when middle button is depressed or changing state)	
b0	Always=0
b1	Always=0
b2	Always=0
b3	Always=0
b4	Always=0
b5	Middle button status; 1=depressed
b6	Always=0

PS/2 COMMUNICATION

At start-up or reset, the PixiPoint waits between 300 and 500 milliseconds, then sends 0xAA to the host, followed by a device ID of 0x00. Then the IC sets itself to its default values, i.e., incremental stream mode with 1:1 scaling and a report rate of 100 Hz. The IC then disables itself until a command is received from the host.

PS/2 REPORTS

The adjacent list shows the PS/2 report formats.

In the data report, each of the two position values (X and Y) is expressed as a 9-bit two's complement integer with the most significant bit (the sign bit) stored separately in byte 1. Z value (wheel or scroll) is expressed as an 8-bit two's complement integer.

If there is an overflow of the accumulator, the maximum positive or negative count is reported and the corresponding overflow bit is set.

PS/2 ERROR HANDLING

For every correct command or parameter received from the host, the SH1201 sends an acknowledge (0xFA). If an invalid command or parameter is received, the SH1201 issues a resend request (0xFE). If an invalid input is again received, the device transmits an error code (0xFC) to the host. Both error and resend request responses are sent by the device within 25 milliseconds. The host may not issue any new commands until either the PixiPoint has responded or 25 milliseconds have elapsed.

PS/2 DATA REPORT

Byte 1			
	b0	Left Button status	1 = depressed
	b1	Right Button Status	1 = depressed
	b2	Middle Button Status	1 = depressed
	b3	Reserved	Always = 1
	b4	X8: MSB of X data, sign bit	1 = negative
	b5	Y8: MSB of Y data, sign bit	1 = negative
	b6	X data overflow	1 = overflow
	b7	Y data overflow	1 = overflow
Byte 2			
	b0	X0: LSB of X data	
	b1	X1	
	b2	X2	
	b3	X3	
	b4	X4	
	b5	X5	
	b6	X6	
	b7	X7	
Byte 3			
	b0	Y0: LSB of Y data	
	b1	Y1	
	b2	Y2	
	b3	Y3	
	b4	Y4	
	b5	Y5	
	b6	Y6	
	b7	Y7	
Byte 4 (for wheel function; sent only if output of Z data is enabled by the driver)			
	b0	Z0: LSB of Z data	
	b1	Z1	
	b2	Z2	
	b3	Z3	
	b4	Z4	
	b5	Z5	
	b6	Z6	
	b7	Z7: MSB or Z data, sign bit	

PS/2 STATUS REPORT

Byte 1			
	b0	Right button	1 = depressed
	b1	Middle button	1 = depressed
	b2	Left button	1 = depressed
	b3	Reserved	Always = 0
	b4	Scaling - 1:1 (0) / 2:1 (1)	
	b5	Disable - (0) / enable (1)	
	b6	Stream - (0) / prompt (1) mode	
	b7		Always = 0
Byte 2			
	b0 - 1	Current resolution setting	
	b2 - 7		Always = 0
Byte 3			
	b0-7	Current sampling rate	

PS/2 MODE COMMANDS

When the Reset Command (0xFF) is received, the SH1201 sets the following default parameters: incremental stream mode, 1:1 scaling, report rate of 100 Hz, and disabled. It then sends 0xAA to the host followed by a device ID of 0x00.

The host sends the Resend Last Data Stream Command (0xFE) when it detects an error in any SH1201 transmission. The device then resends the last output data packet to the host. This transmission occurs after a PixiPoint transmission, and before the host enables the interface allowing the next PixiPoint output.

The Set Default Status Command (0xF6) re-initializes the device to its condition at power-up.

The Disable Command (0xF5) stops the device from transmitting all reports. However, the mode does not change; the PixiPoint is still able to respond to commands. If the disable command is issued while the device is transmitting a report, the SH1201 immediately stops the transmission and disables itself.

The Reset Echo Mode Command (0xEC) returns the device to its previous mode, and disables it.

The Set Prompt (Remote) Mode Command (0xF0) sets the device to Prompt Mode. Data values are then only reported in response to a Read Report Command (0xEB).

If the Set Echo Mode Command (0xEE) is received, the PixiPoint immediately returns any data bytes except 0xFF or 0xEC.

If the PixiPoint is in incremental stream mode, the Enable Command (0xF4) allows it to begin data transmission. If the device is in prompt mode, the enable command only updates the internal status of the PixiPoint.

The PixiPoint responds to the Set Sampling Rate Command (0xF3) in both stream and prompt Modes but only updates its internal status if this command is enacted while the device is in stream mode.

The SH1201 responds to the Read Device Type Command (0xF2) with the device ID of 0x00.

The Read Report Command (0xEB) prompts the PixiPoint for a report. The report occurs even if the device has not moved or if the status of the buttons did not change.

The Set Incremental Stream Mode Command (0xEA) sets the PixiPoint to stream mode and disables the device.

The Status Request Command (0xE9) returns a 3-byte status report.

The Set Resolution Command (0xE8) controls resolution, the Set 2:1 Scaling Command (0xE7) enables a coarse/fine tracking response, and the Set 1:1 Scaling Command (0xE6) enables the values of movements to be transmitted to the host without any scaling. Due to Semtech's advanced motion algorithm, set resolution and scaling commands are acknowledged and reported as activated, but their contents are ignored.

PIXIPOINT EXTENDED PS/2 SPECIFICATION

Normal operations

At power-up or reset, the PixiPoint PS/2 pointing device acts as a standard legacy three-button mouse; as such, it fully supports all applicable PS/2 commands, issues three-byte reports, and has a device ID equal to zero. It can also be switched into wheelmouse mode by the special wheelmouse command sequence; in wheelmouse mode, it fully supports all PS/2 commands a standard wheelmouse supports, issues four-byte reports, and has a device ID equal to three.

These standard functions do not affect or interfere with the PixiPoint extended PS/2 protocol or its proprietary controls.

Extended operations

The PixiPoint extended PS/2 protocol includes 14 commands, 0xC0 through 0xCD. All these PixiPoint extended PS/2 commands are available at any time regardless of the current mode of the device (either standard legacy mode with ID 0 and 3-byte reports, or wheelmouse mode with ID 3 and 4-byte reports).

If required in order to determine whether the device is a PixiPoint device that can process the PixiPoint extended PS/2 commands, the driver should perform a special "sequential" (a.k.a. "knocking") command, shown in Table 1 below. (Note a PixiPoint device can execute the PixiPoint extended PS/2 commands whether this sequential command is received or not.) All elements of this sequential command are valid mouse commands, but the exact order and number of these commands are very unlikely to happen during operations of a standard mouse driver. The last command in the set is "Read device type" (0xF2). A PixiPoint extended PS/2 protocol device responds to this command by returning a special value device ID; which value it returns depends on its capabilities. A special value is returned for the device ID only for a single "Read device type" (0xF2) command issued as part of the special sequential command. Other "Read device type" (0xF2) commands, not issued as part of the special sequential command, return the standard device ID for the current mode, either 0 or 3.

Read PixiPoint extended ID sequential command

Command / data description	Host Data	Device Data
Set sampling rate	0xF3	
Acknowledgement		0xFA
80 reports/second	0x50	
Acknowledgement		0xFA
Set Sampling Rate	0xF3	
Acknowledgement		0xFA
60 reports/second	0x3C	
Acknowledgement		0xFA
Set sampling rate	0xF3	
Acknowledgement		0xFA
100 reports/second	0x64	
Acknowledgement		0xFA
Read device type	0xF2	
Acknowledgement		0xFA
PixiPoint extended device ID		0x20

The driver should check the device ID returned by the sequential command. Normal-mode-only pointing devices should return a device ID of 0x00 or 0x03. If a device ID other than 0x20 is returned, the device is not a PixiPoint.

If the device is a PixiPoint, the driver can initialize the PixiPoint with any appropriate proprietary controls, the correct mode (three-byte or four-byte report mode), the sampling rate, stream/prompt mode, and issue an Enable command to start operations.

PIXIPOINT EXTENDED PS/2 SPECIFICATION (CONT'D)

The following table shows the command byte, the command name, the number of data bytes (excluding the command byte) sent to the PixiPoint, and the number of data bytes returned by the PixiPoint (excluding the acknowledge byte).

PixiPoint extended PS/2 commands

Command byte	Command name	Bytes sent	Bytes returned
0xC0	Set tap sensitivity	1	0
0xC1	Set translation profile	1	0
0xC2	Read extended status	0	1
0xC3	Write extended status	1	0
0xC4	Power down	0	0
0xC5	Read device type	0	1
0xC6	Read device version	0	1
0xC7	Read XY gain	0	1
0xC8	Write XY gain	1	0
0xC9	Read Z gain	0	1
0xCA	Write Z gain	1	0
0xCB	Read Checksum	0	3
0xCC	Read direction	0	1
0xCD	Write direction	1	0

PIXIPOINT EXTENDED PS/2 SPECIFICATION (CONT'D)

Set tap sensitivity (0xC0)

This command byte is followed by one byte of data. The extended mode device responds to each of the two bytes with Acknowledge (0xFA). The value of the second byte is written to the tap sensitivity register which controls the tapping sensitivity of the PixiPoint as shown in this table.

Note: If Z-axis functionality is not required, some 25% savings in power consumption by the PixiPoint can be realized by termination of the Z-axis sampling. Whenever the value of the tap sensitivity register changes to or from the value of 0x80, the PixiPoint performs a self-calibration cycle of approximately 500 ms duration. The sensor should not be touched while the self-calibration cycle is in progress.

Tap sensitivity register

Value	Meaning	Comment
0x00	OFF	Tap feature is disabled
0x01	Soft	Default, recommended setting
0x02	-	
0x03	Medium	
0x04	-	
0x05	Hard	
0x06	-	
0x07	Very Hard	
0x08 – 0x7F	-	All these values are reserved
0x80	OFF	Z-axis sampling is stopped
0x81 – 0xFF	-	All these values are reserved

Set translation profile (0xC1)

This command byte is followed by one byte of data. The extended mode device responds to each of the two bytes with Acknowledge (0xFA). The value of the second byte controls the translation profile between the force on the PixiPoint sensor and relative motion as shown in this table.

Translation profile register

Value	Meaning	Comment
0x00	Semtech Profile #1	Default, recommended setting
0x01 – 0xFF		All these values are reserved

Read extended status (0xC2)

The extended mode device responds to the command byte with an Acknowledge (0xFA), and then returns a one-byte value. See the section on the Write extended status command for the description of the extended status register.

Write extended status (0xC3)

This command byte is followed by one byte of data. The extended mode device responds to each of the two bytes with Acknowledge (0xFA). The value of the second byte is written to the extended status register. See the following table for the description of individual bits.

Note: Possible values for the extended status register are 0x00 to 0x7F (i.e. it is NOT required to pass "special" values like 0xFF, 0xFE, etc. via the 8042 host).

PIXIPOINT EXTENDED PS/2 SPECIFICATION (CONT'D)

Extended status register

Bit number	Name	Default / power-up value	Comment
0	Right Primary Enable	0	When set (=1) this bit directs sensor press activation to the Right button. When this bit is reset (=0) sensor press activation is directed to the Left button.
1	Left Wakeup Enable	0	When set (=1) AND the PixiPoint is in the extra-low-power mode, press on the Left Button triggers generation of the Left Button Press (and, possibly, zero motion) report. When cleared (=0), the Left button is driven low and ignored in the extra-low-power mode. See note below.
2	Right Wakeup Enable	0	When set (=1) AND the PixiPoint is in the extra-low-power mode, press on the Right Button triggers generation of the Right Button Press (and, possibly, zero motion) report. When cleared (=0), the Right button is driven low and ignored in the extra-low-power mode. See note below.
3	Middle Wakeup Enable	0	When set (=1) AND the PixiPoint is in the extra-low-power mode, press on the Middle Button triggers generation of the Middle Button Press (and, possibly, zero motion) report. When cleared (=0), the Middle button is driven low and ignored in the extra-low-power mode. See note below.
4	Reserved	0	Reserved for future use, keep cleared (=0)
5	Slow Drag Disable	0	When set (=1) this bit disables slowing-down of the cursor speed when primary button is activated by sensor press. When cleared (=0), the speed of the cursor is reduced when primary button is activated by sensor press.
6	Reserved	0	Reserved for future use, keep cleared (=0)
7	Reserved	0	Reserved for future use, keep cleared (=0)

Note: If reports from the PixiPoint are disabled while the "Power down" command is issued, the left, middle, and right buttons' pins are driven low and ignored in extra-low-power mode, regardless of the state of bit 1 through bit 3 of the extended status register.

PIXIPOINT EXTENDED PS/2 SPECIFICATION (CONT'D)

Power down (0xC4)

The extended mode device responds to the command byte with Acknowledge (0xFA). The "Power down" command forces the PixiPoint into extra-low-power mode.

If external PS/2 device is connected to the pass-through PS/2 port, the PixiPoint receives but ignores any motion reports from the external device until the PixiPoint returns to normal operating mode. The PixiPoint operates in normal (high) power mode for the duration of the transmissions from the external PS/2 device, but returns to extra-low-power mode as soon as the transmissions finish. Hot-plug of the external PS/2 pointing device operates normally in extra-low-power mode.

The PixiPoint receives and acknowledges all commands from the host while it is in extra-low-power mode by temporarily resuming normal operations for the duration of transmission, but returns to extra-low-power mode immediately after the last Acknowledge to host is transmitted (see the two exceptions below).

To resume normal operations, the host should do one of these two actions:

1. Issue an Enable (0xF4) command. In this case reinitialization is not needed, and normal operations commence after a brief recalibration delay (~500ms; all communications are active during recalibration).

2. Issue a Reset (0xFF) command and re-initialize the PixiPoint.

Read device type (0xC5)

The extended mode device responds to the command byte with Acknowledge (0xFA), and then returns a one-byte value. This data is used for identification of the IC; it is hard-coded in the firmware.

Read device version (0xC6)

The extended mode device responds to the command byte with Acknowledge (0xFA) , and then returns a one-byte value. This data is used for identification of the IC; it is hard-coded in the firmware.

Read XY Gain (0xC7)

The extended mode device responds to the command byte with Acknowledge (0xFA), and then returns a one-byte value. See the "Write XY gain" command for the description of the data.

Write XY gain (0xC8)

This command byte is followed by one byte of data. The extended mode device responds to each of the two bytes with Acknowledge (0xFA). The value of the second byte is written to the XY gain register. This parameter allows fine control of the gain in the X/Y (but not Z) A/D processing channels, in order to accommodate various sensors and/or heights of the sensors. Power-up value depends on sensor selection and configuration.

Read Z gain (0xC9)

The extended mode device responds to the command byte with Acknowledge (0xFA), and returns a one-byte value. See the "Write Z gain" command for the description of the data.

PIXIPOINT EXTENDED PS/2 SPECIFICATION (CONT'D)

Write Z gain (0xCA)

This command byte is followed by one byte of data. The extended mode device responds to each of the two bytes with an Acknowledge (0xFA). The value of the second byte is written to the Z gain register. This parameter allows fine control of the gain in the Z (but not X/Y) A/D processing channel, in order to accommodate various sensors. Power-up value depends on sensor selection and configuration.

Read CheckSum (0xCB)

The extended mode device responds to the command byte with Acknowledge (0xFA), and then calculates and returns a three-byte value (24-bit CheckSum). This command is intended for generation of the digital signature of the firmware, and quick manufacturing test of the ROM-mask devices. The data set consisting of data returned by "Read device type," "Read device version," and "Read CheckSum" is constant (i.e., for a device with the specific Type and Version, the CheckSum can only have a single, non-changing value). The range of ROM addresses over which the CheckSum is calculated is preset in the device's firmware and can not be changed.

Read direction (0xCC)

The extended mode device responds to the command byte with Acknowledge (0xFA), and returns a one-byte value. See the "Write direction" command for the description of the data.

Write direction (0xCD)

This command byte is followed by one byte of data. The extended mode device responds to each of the two bytes with an Acknowledge (0xFA). The value of the second byte is written to the direction register. This register allows control of the direction (swapping of X and Y signals), and polarity of the X, Y, and Z signals, in order to accommodate various sensors. Power-up value is 0x00 if the Select (pin 19) is floating. Power-up value is 0x80 if Select (pin 19) is grounded. See the following direction register table for the description of individual bits.

Direction register

Bit number	Description	Power-up value (when Select is floating)	Power-up value (when Select is grounded)	Comment
0	X sign	0	0	A value of 1 inverts the X signal
1	Y sign	0	0	A value of 1 inverts the Y signal
2	XY swap	0	0	A value of 1 swaps the X and Y signals
3	Z sign	0	1	A value of 0 inverts the Z signal
4	Reserved	0	0	Ignored, keep cleared
5	Reserved	0	0	Ignored, keep cleared
6	Reserved	0	0	Ignored, keep cleared
7	Reserved	0	0	Ignored, keep cleared

CIRCUIT NOTES

Power Circuit

The SH1201 reference design uses the SC431 shunt regulator, which is recommended. The SC431 works with the REGDIS pin to reduce power consumption.

Operational amplifier

For a power supply above 4 V, a lower cost op amp like the LM358/2904 can be used instead of the LMV321.

Integration circuit

The integration capacitor is 180 pF. A greater capacitance would reduce X, Y, Z axis sampling gain.

Compensation capacitors

C6 (56 pF) compensates for capacitance of sensor drive pins and layout. Measure waveforms at AD (pin 31). If the initial value of the six sampling waveform is not half of op amp output swing, use a different-valued capacitor here. Greater capacitance yields a smaller initial sampling value.

Low-impedance sensors

A low-impedance force stick requires resistors to boost total device impedance above 600 Ω.

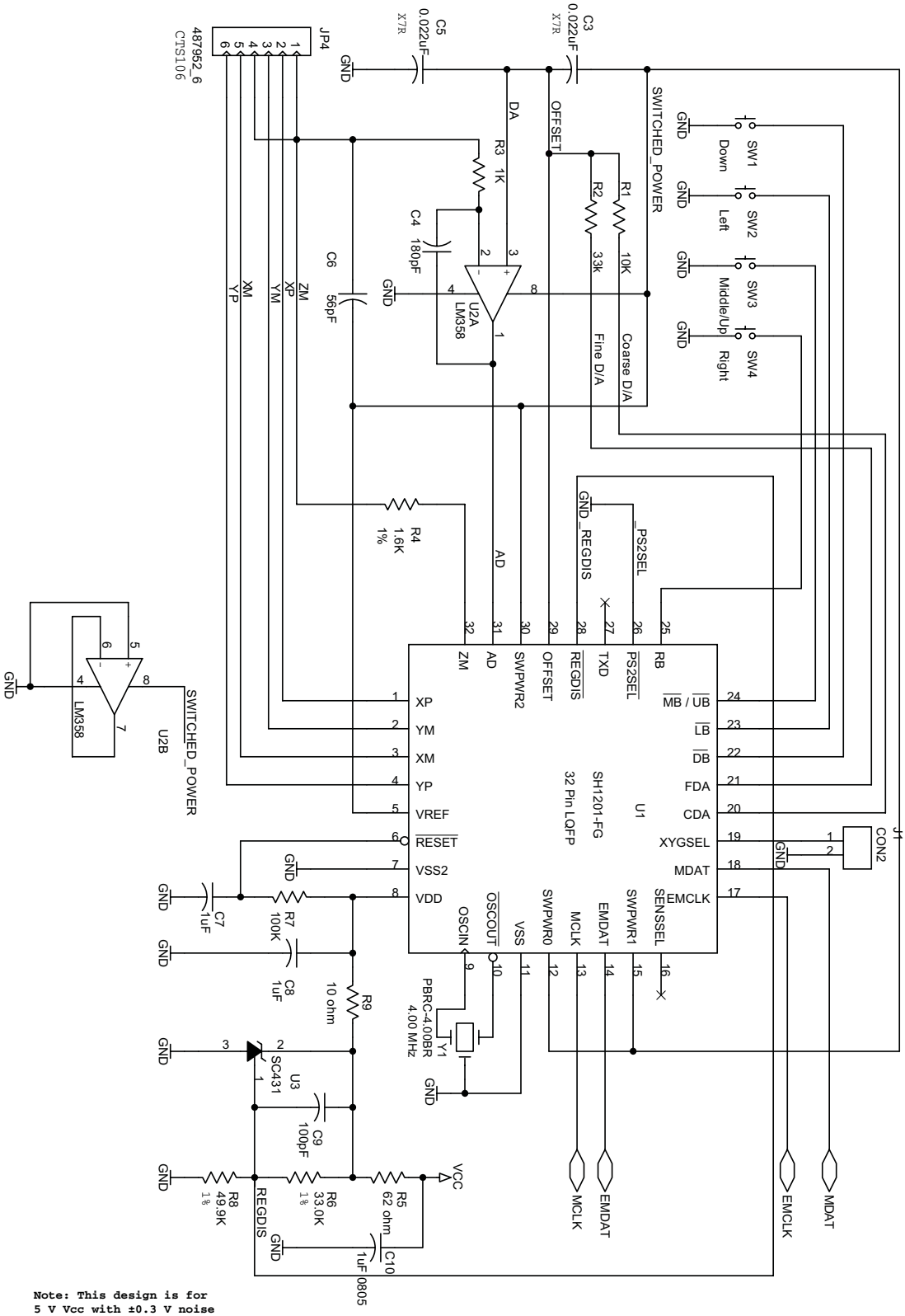
External PS/2

L1 limits surge current from hot-plug of external mouse.

Clock generator

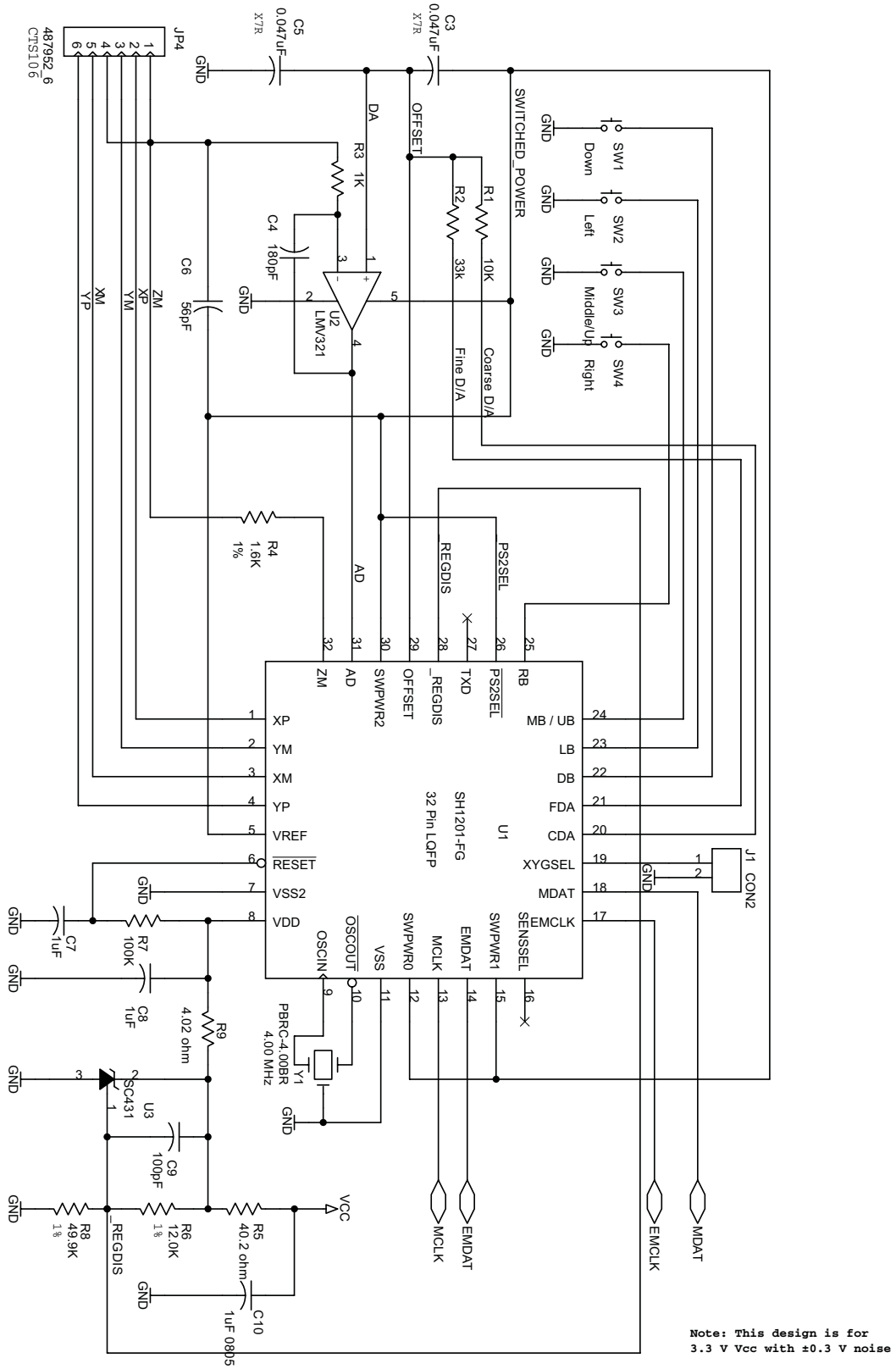
4 MHz resonator with built-in load capacitors is recommended: PBRC-4.00BR or equivalent.

HIGH-SPEED PS/2 MODE SCHEMATIC FOR THE SH1201-FG PIXIPOINT



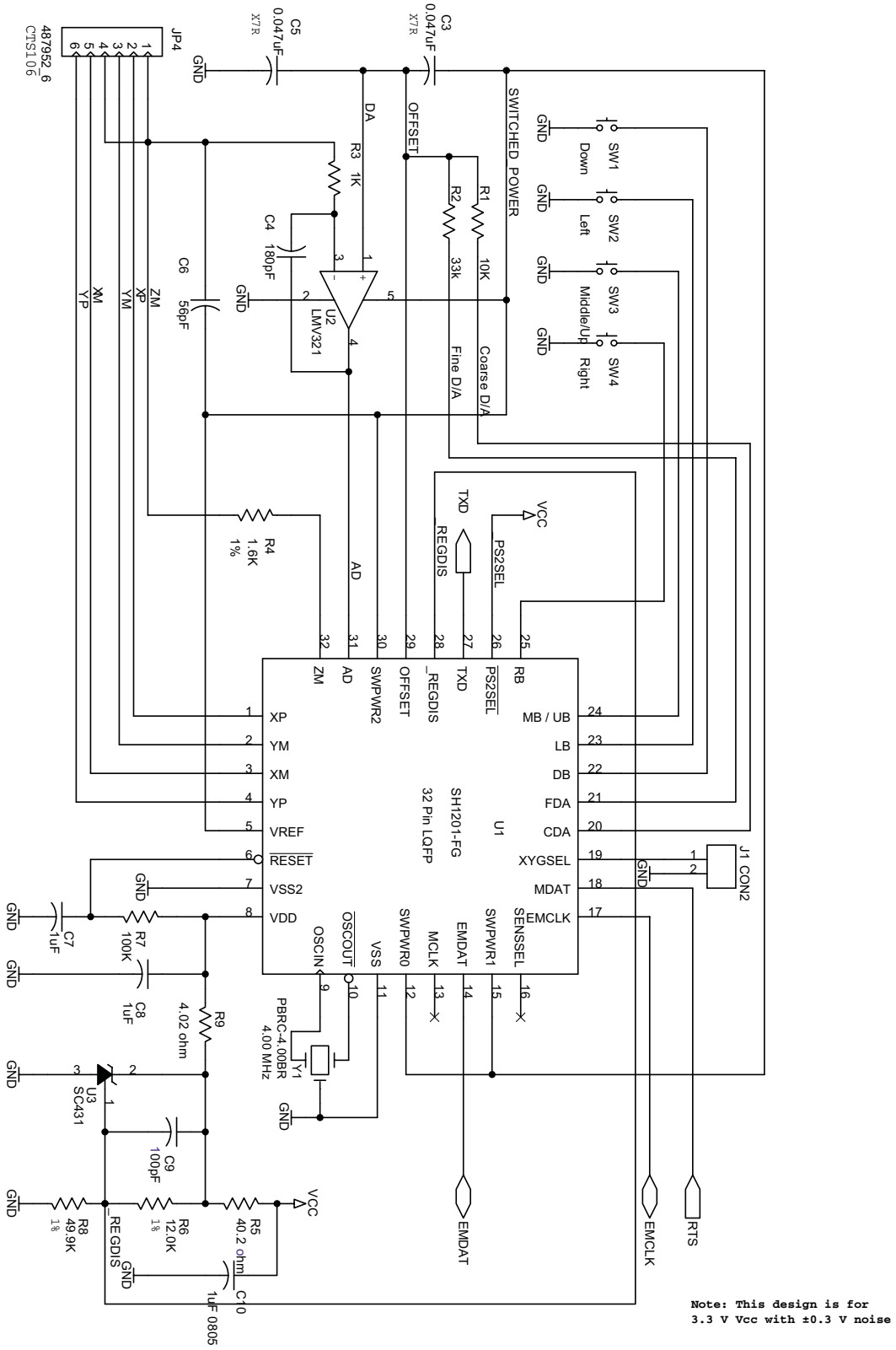
Note: This design is for 5 V Vcc with ±0.3 V noise

LOW-SPEED PS/2 MODE SCHEMATIC FOR THE SH1201-FG PIXIPOINT

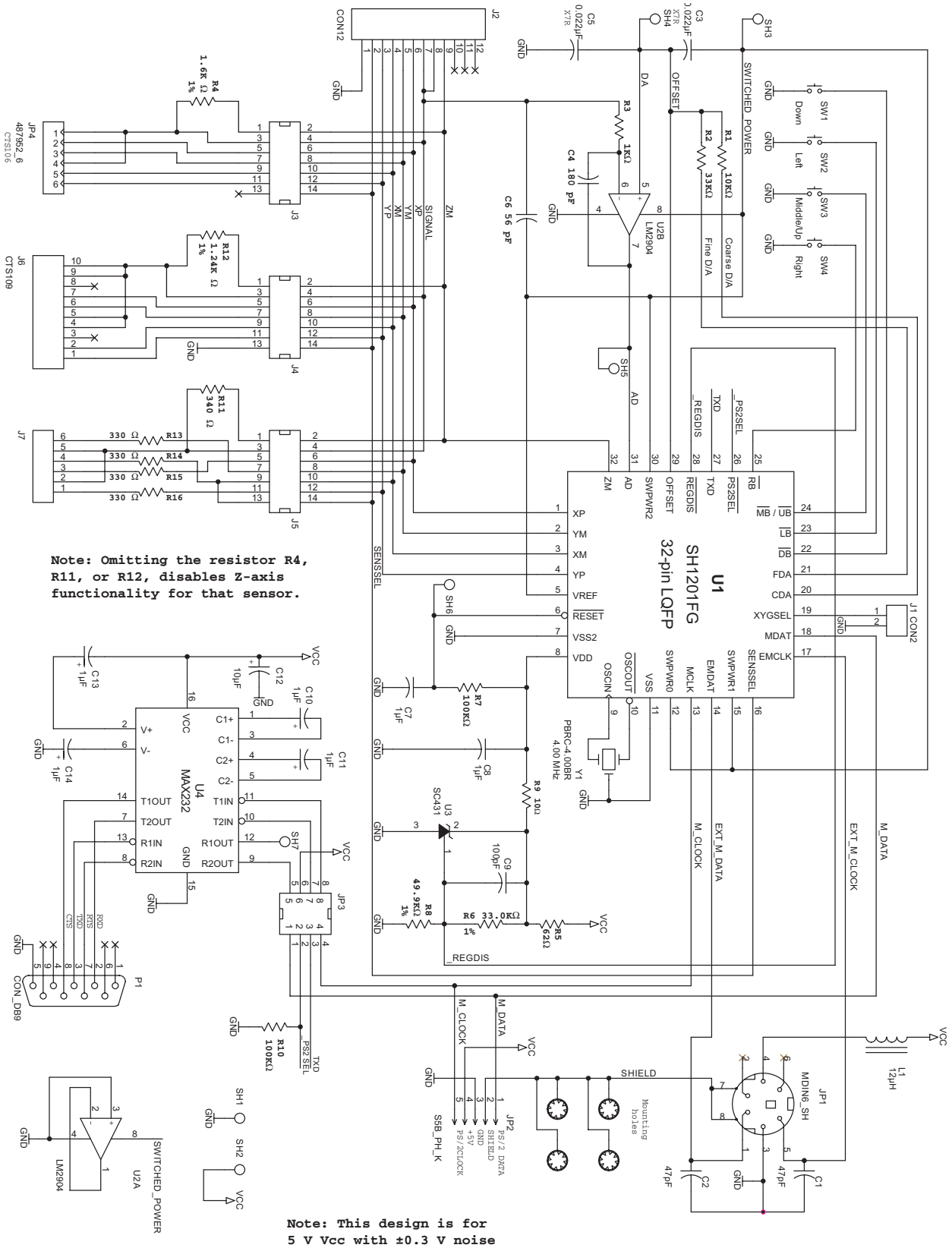


Note: This design is for 3.3 V Vcc with ±0.3 V noise

SERIAL MODE SCHEMATIC FOR THE SH1201-FG PIXIPOINT



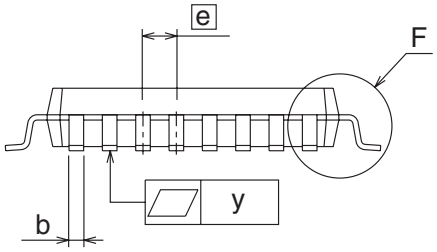
EVALUATION BOARD SCHEMATIC FOR THE SH1201-FG PIXIPOINT

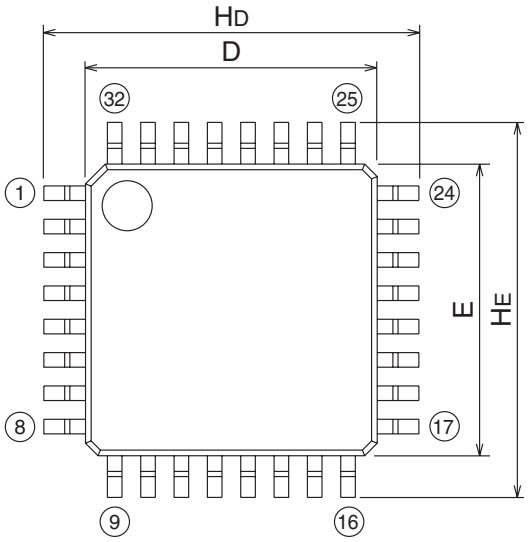


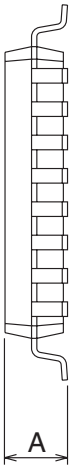
Note: Omitting the resistor R4, R11, or R12, disables Z-axis functionality for that sensor.

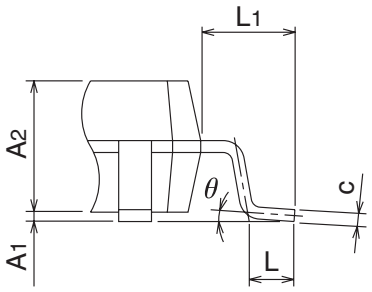
Note: This design is for 5 V Vcc with ±0.3 V noise

MECHANICALS FOR THE SH1201FG



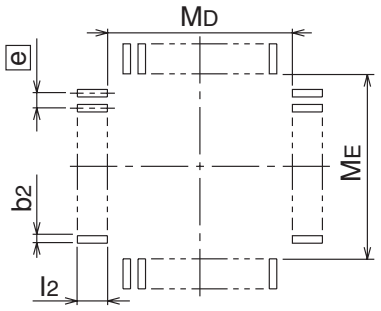






Detail F

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	1.55
A_1	0	0.1	0.2
A_2	–	1.4	–
b	0.3	0.35	0.45
c	0.105	0.125	0.175
D	6.9	7.0	7.1
E	6.9	7.0	7.1
e	–	0.8	–
H_D	8.8	9.0	9.2
H_E	8.8	9.0	9.2
L	0.3	0.5	0.7
L_1	–	1.0	–
y	–	–	0.1
θ	0°	–	10°
b_2	–	0.5	–
l_2	1.0	–	–
M_D	–	7.4	–
M_E	–	7.4	–



Recommended PCB Footprint

ELECTRICAL SPECIFICATIONS

Absolute maximum ratings

Ratings	Symbol	Value	Unit
Supply voltage	V_{DD}	-0.3 to 7.0	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	T_A	T_{LOW} to T_{HIGH}	°C
SH1201		-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		2.7	5.0	5.5	V
Output voltage (10 µA load)	V_{OH}	V_{DD} - 0.1			V
	V_{OL}			0.1	
Input high voltage	V_{IH}	0.8V_{DD}		V_{DD}	V
Input low voltage	V_{IL}	V_{SS}		0.2V_{DD}	V
Input current	I_{IN}			+/- 1	µA
Supply current (V_{DD}=5.0V_{DC}+/-10%, V_{SS}=0)	I_{DD}		3.0	6.5	mA

Control timing (Vdd = 5.0 V_{DC} +/-10%, V_{SS} = 0 V_{DC}, temperature range = T_{LOW} to T_{HIGH} unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Frequency of operation	fOSC				
■ Crystal option			4.0		MHz
■ External clock option			4.0		MHz

Sensor characteristics

Characteristic	Symbol	Min	Typ	Max	Unit
Resistance	Rx	0.6 K		10 K	Ohms
Matching	Rx1/Rx2	75		125	%
	Ry1/Ry2	75		125	%

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