



MICROCHIP

TSHARC-A2 Touch Screen Microcontroller Application Guide Ver. 2.0

3.3 – 5vDC 28 pin SOIC

12 – Bit Resolution

TTL, RS-232 and USB

Auto detect 4, 5, and 8 wire analog resistive touch screens

Microchip TSHARC products use standard silicon to produce a variety of touch screen controller chip solutions. The chip part number and chip revision is laser marked on the top surface of the each microcontroller.

It is important to make sure that adequate static precautions are taken when handling any TSHARC touch screen controller chip.

Document Revision and Copyright

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Introduction

This manual has been written for users of the Microchip Technology Inc. **TSHARC-A2** touch screen micro-controller chip. The TSHARC touch screen controller chips and software described within this document are assumed to be used with four, five or eight wire analog resistive touch screen products manufactured by a variety of touch screen manufacturers. Touch screens between manufacturers vary with regards to light transmission, sensitivity, contact resistance, capacitance and other electrical characteristics. Because touch screen quality and electrical characteristics may vary between touch screen technologies and manufacturers the actual, overall performance may vary between touch screen overlay manufacturers' products. While Microchip's touch screen controllers and drivers improve the performance of low quality or damaged touch screens, Microchip does not guarantee the performance of or recommend the use of low quality touch screen overlay products in any touch screen implementation.

A great deal of attention has been paid to eliminate potential problems with various touch screen manufacturers. Microchip Technology has tested the TSHARC controllers with the following touch screen overlay manufacturers' analog resistive touch screens. We have identified substantial specification variance within each manufacturer and between manufacturers touch screens. While most of the manufactures we tested did fall within a functional specification, it is important to request electrical and mechanical specifications from your touch screen overlay manufacturer to insure uniform quality and performance. The specification details that should be provided by your touch screen overlay supplier include lead to lead resistance, sheet resistance, and linearity of ITO.

Touch Screen Overview

4 and 8 wire touch screens are typically produced with higher resistance transparent conductive film (ITO Indium Tin Oxide) than 5 wire touch screens. Most, touch screen resistance falls within 100 – 400 Ohm per square. Because 4 and 8 wire touch screens typically have a higher resistance than 5 wire sensors, you will find most battery powered applications using this technology. You will also find that 4 and 8 wire touch screens are more linear than 5 wire. The advantage of a 5 wire touch screen is that they are typically more mechanically durable (top sheet does not need to be linear) and are less affected by environmental variation.

Five Wire touch screens come in a wide variety of sheet resistance. In some cases, because of the 5 wire construction, the resistance may be lower than the 50 ohm specification. While these touch screens require more power to drive them, this does not imply poor quality.

Once resistance drops below an optimum level so does the resolution. In contrast, as resistance increases, depending upon the construction, contact resistance begins to negatively affect the touch screen's performance. The negative effect of a high or low resistance touch screen can be managed by properly implementing the correct circuit. It should be understood that extremes in either direction will negatively influence the performance of any efficient circuit design. In order to maximize efficiency and performance a higher resistance, linear, environmentally stable touch screen is recommended.

The three paragraphs above barely scratch the surface of touch screen technology. Your product design requirements will help you identify the touch screen technology and construction that will best suit your application. Please contact Microchip Technology Inc. for more unbiased touch screen material science information and a list of recommended TSHARC chip and circuit designs to fit your application.

Software and Device Drivers

All Microchip device drivers are designed specifically and exclusively to be used with Microchip TSHARC™ touch screen controller products. Microchip drivers may be used to support 3rd party controller products only when authorized specifically, in writing, by Microchip. Microchip Technology Inc. develops, supports and maintains all products sold with the Microchip® or TSHARC™ trademark and does not use any third party technical resources to develop any of its software, device drivers or hardware products. Drivers are available for Windows™ 9x, 2K, ME, XP, XPe, NT™, DOS™, CE™, CE Net, Linux™, MAC and other operating systems and their variations.

Custom or private labeled drivers and firmware is available. Customized and private labeled software and hardware licenses are available which may be used to enable various non-Microchip communication protocols, special functions, application specific utilities or OEM contact information. Contact Microchip for details.

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TSHARC-A2 Micro-controller Core Features

- **RoHS Compliant**
- **Industrial Temperature -40c to +85c**
- Moisture sensitivity rating: MSL1
- 300 Mil 28 pin SOIC Package
- High-performance RISC CPU
- Power-up Timer (PWRT)
- Brown Out Detect
- Brown out Voltage: 2.7v
- Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT)
- Operating voltage Standard: 3.3Vdc or 5Vdc +/- 5%
- True 12-bit ratio metric analog to digital converter
- Flash/Data EEPROM Retention: > 40 years
- Hardware Enable/Disable
- Self-programmable under software control
- Single-Supply 3.3V or 5V flash programmable
- Automatically detected communication type
 - 4 byte RS-232 and USB
 - Low speed USB device HID compliant at 1.5Mbps/sec
 - Low power suspend mode for USB < 500uA
 - RS-232 Default is set to 9600, but other Baud rates are available upon request.
- Other custom RS-232 communication protocol available by special request.
- Auto-detect all manufacturers analog resistive touch screens.
 - 4 wire
 - 5 wire
 - 8 wire
- Dynamic rise-time and sampling routines
- Touch Screen Resistance Specification is 50 – 2k ohm sheet resistance lead to lead.
 - While the "A2" micro-controller will function properly with low (<100 Ohms) resistance touch screens, reduced resolution may be apparent.

ELECTRICAL CHARACTERISTICS (Absolute Maximum Ratings)

Ambient temperature under bias (Operating)	-40°C to +85°C
Storage temperature	-40°C to +85°C
Voltage on any pin with respect to Vss (except VDD, MCLR and RA4)	-0.3V to (VDD + 0.3V)
Voltage on VDD with respect to Vss	-0.3V to +7.5V
Total power dissipation (Note 1)	1.0W
Maximum current out of Vss pin	300 mA
Maximum current into VDD pin	250 mA
Input clamp current, I _{IK} (V _I < 0 or V _I > VDD).....	±20 mA
Output clamp current, I _{OK} (V _O < 0 or V _O > VDD)	±20 mA
Maximum output current sunk by any I/O pin.....	25 mA
Maximum output current sourced by any I/O pin	25 mA
Maximum current sunk by all ports	200 mA
Maximum current sourced by all ports	200 mA

Note 1: Power dissipation is calculated as follows: $P_{dis} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD} - V_{OH}) \times I_{OH}\} + \sum (V_{OL} \times I_{OL})$
 2: Voltage spikes below Vss at the MCLR/VPP/RE3 pin, inducing currents greater than 80 mA, may cause latch-up.
 Thus, a series resistor of approximately 75 Ohms should be used when applying a "low" level to the MCLR/VPP/ RE3 pin, rather than pulling this pin directly to Vss.

Part Numbers

Standard 12-Bit 5 Volt

HSA2-040SIA/A2S20A

Standard 12-Bit 3.3 Volt

HSA2-040SAA/A2320A

RS-232 and USB Communication Protocol

TSHARC USB Protocol

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	0	0	0	0	0	P
2	X7	X6	X5	X4	X3	X2	X1	X0
3	0	0	0	0	X11	X10	X9	X8
4	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0
5	0	0	0	0	Y11	Y10	Y9	Y8

TSHARC RS232 Protocol

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	1	P	X11	X10	X9	Y11	Y10	Y9
2	0	X8	X7	X6	X5	X4	X3	X2
3	0	Y8	Y7	Y6	Y5	Y4	Y3	Y2
4	0	0	0	0	X1	X0	Y1	Y0

Where:

P	- 0 Pen-Up, 1 Pen-Down
X11-X0	- 12 bit X position data
Y11-Y0	- 12 bit Y position data

Tx and Rx Notation

The TSHARC RS232 controller designs are labeled as host-centric.

Tx is the Transmit for the host, and Rx is the Receive.

Device Driver Software for all major operating systems configurations

Microchip Technology Inc. has device driver software available for all TSHARC touch screen controller chip and board solutions. The software drivers may be downloaded at no additional charge at: www.microchip.com.

Reported Microchip resolution is dependent upon the hardware A-D converter specification. Microchip device driver software is designed to deliver true 10 or 12 bit hardware resolution respective to the touch screen controller hardware.

The TSHARC device driver software enables you to configure the touch screen operation to meet your needs.

The following is a list of features and utilities available with Microchip's UniWinDriver™ software:

- 1) Touch screen calibration utilities
- 2) Touch screen linearization utilities
- 3) Touch screen alignment utilities
- 4) Multi-monitor calibration and configuration utility
- 5) Adjustable calibration inset
- 6) Edge acceleration
- 7) Touch modes
 - a. Normal mouse emulation
 - b. Touch Up mode
 - c. Touch Down mode
- 8) User adjustable.
 - a. Microchip proprietary touch screen friendly timed right click event
 - b. Touch event area setting
 - c. Touch sound enable / disable
- 9) Other special features also included. Please see the complete driver manuals available at the www.microchip.com web site for further details.

Note: TSHARC device driver utilities vary between operating systems and operating system varieties and versions. Currently Microchip supports the following Windows® Operating systems: DOS, Win3.1x, 9x, ME, Xp, XPe, 2k, CE, CENet, Tablet. TSHARC driver for Linux, and MAC are also included with all TSHARC touch screen controller products.

ESD Specifications

Implementation

The Devil Ray reference board implements a dual diode array in a serial connection to provide static protection on all 8 input lines. Capacitors are added to the power bus to aid in dissipating the static charge. **These capacitors must be mounted near the diodes, but far from the controller chip, on the PCB layout.**

Testing Requirements

- Controller must withstand +/- 24 kVA air discharge through the sensor.
- Controller must withstand a +/- 8kVA contact discharge on the H2/H3 header pins.
- Controller cannot report false points as a result of a static discharge.
- Controller must remain in a functioning state without any interaction after the discharge.
 - Allows for the chip to be reset, so long as it resets automatically
 - Power cycle cannot be required to restore functionality.
- Requirements must be met on 4, 5, and 8 wire sensors.
 - Includes low-Ohm touch sensors.
 - Sensor may be simulated for this test with a resistor array of a similar load resistance.



Although Microchip Technology Inc. has taken steps to protect your touch screen controller from transient voltage, it is important to make all grounding, communication and touch screen connections to the controller and touch screen. This must be done before powering on your computer, video monitor or touch screen controller. Failure to follow this procedure may result in damage to your controller and/or communication port. If you believe that your application will require additional static protection, it is up to you to determine the appropriate static protection needed to protect your electronics from transient voltage.

Failure to take the necessary precautions may result in damage to your controller. Microchip does not warranty the TSHARC controller against transient static discharge damage.

Noise Considerations

Filtering capacitors are included on TC1 and TC2. These lines are selected because they are the lines that measure voltage with the A/D converter. These capacitors in conjunction with the resistance of the touch sensor create a low-pass filter. This low-pass filter removes any high frequency noise from the line being measured.

Care must be taken when selecting these capacitors. Any increase in capacitance to the sensor lines will affect the rise-time required to reach a steady-state. Capacitors may be included on any or all of the touch sensor lines, but our controller chip is optimized when this capacitance is kept to 20nF across all lines. Any increase may reduce the performance of the sampling rate.

Decoupling capacitors, .1 uF, are added to the Vcc pin of all IO chips in the circuit.

A filtering capacitor of .22 uF or more is required on pin 14 to maintain a stable USB module.

Jumper Configurations

When implementing a jumper-configurable design, consider the power requirements for USB.

The USB chapter 9 specifications dictate that in suspend the device may not draw more than 500uA.

Hardware Enable and Disable

Implemented in the A2 design is a hardware disable/enable. This is done by pulling Pin 1 of the chip high or low. To enable the chip, pull the pin high to Vcc. To disable the chip, pull Pin 1 to ground.

It is important to understand that this feature is **not** a hardware **reset**. It merely suppresses X-Y coordinate reporting. Commands will still be communicated to the controller and the controller will continue to respond to these commands.

By default this feature is not enabled. For inquiries about this feature, please contact Microchip Technology Inc. for details about the specific firmware version that includes this feature.

LED Status Codes

Included in the controller chip design is a diagnostic LED. This LED is not only important during general operation, but is integral during prototyping and troubleshooting a design.

- 1) Upon boot, there will be 2 flashes for communication type and 1 flash for screen type. This means there are 3 flashes associated with the boot of the controller.
- 2) If no communication type is found, but the controller is powered, the LED will respond with a mid-level 'ON' response.
- 3) Pulling J4 and J5, the EEPROM reset jumpers, to ground will cause the LED to light while busy. The LED will then turn off when completed. The LED will remain off for .25s, and will re-enumerate after this time.

Auto-Detection for Screen Type

For the A2 firmware, an auto-detection routine is included to determine what type of design is being used on board. This includes a two multiplexor design, a one multiplexor design, and a no multiplexor design. The chip auto-detects for the number of multiplexors in the circuit.

Two Multiplexor Designs

This design allows for full auto-detection of screen type.

Single Multiplexor Designs

This design allows for auto-detection of 4, 5, and most 8-wire screen types.

No Multiplexor Designs

This is for 5-wire only implementation.

Two Multiplexor Signal Table

Channel	MUX 0			MUX 1		
	Ref+	Ref-	Screen Type	Ref+	Ref-	Screen Type
0	TC0	TC1	4WA x	S0	S2	8WA y 8WC y
1	TC2	TC4	4WA y 4WB y	TC3	S1	8WA x
2	TC3	S2	8WB y	TC3	TC1	4WB x 5W
3	S1	S0	8WB	TC2	S1	8WC

Single Multiplexor Signal Table

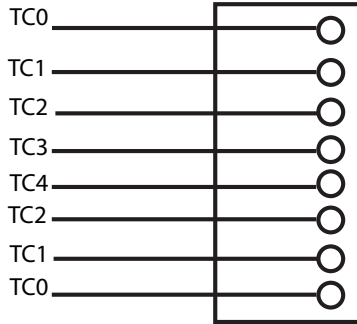
Channel	MUX 0		
	Ref+	Ref-	Screen Type
0	TC0	TC1	4WA
1	TC2	TC4	4WA y 4WB y
2	TC3	S2/TC1	8WB y / 5W 4WB x
3	S1	S0	8WB x

No Multiplexor Designs

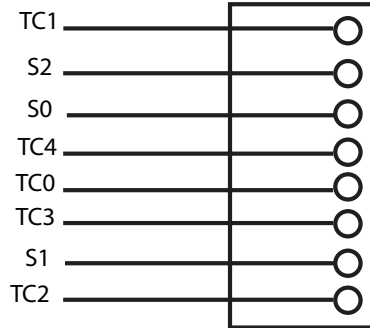
Please connect Ref- to TC1 and Ref+ to TC3.

Header Pin-Out

H2 Header



H3 Header



Microchip Origin

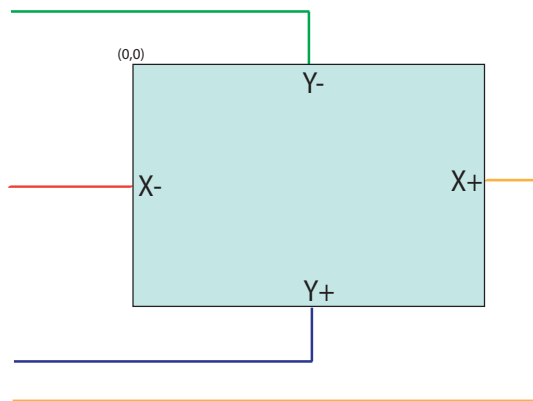
To remain consistent with Microsoft Window's operating systems, Microchip Technology Inc. has chosen our relative origin to remain in the upper left corner.

In emulation mode, the origin will be in the lower left corner. This is done automatically in the firmware to remain consistent with our standard origin by adding an additional flip-state. This flip-state allows both our standard origin and the emulated origin to be recognized by the controller, depending on what operation mode is chosen.

Microchip firmware will output any of the 8 possible flip-states when the EEPROM is properly configured.

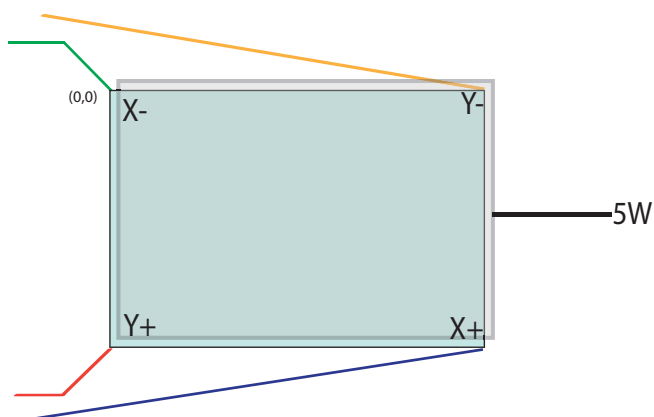
Touch Screen Pin-Out

4-Wire Configurations



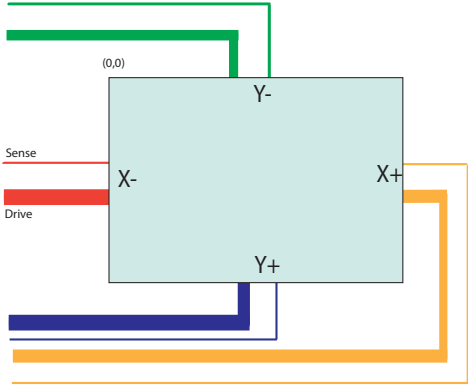
	Right (X+)	Left (X-)	Bottom (Y+)	Top (Y-)
4WA	TC0	TC1	TC2	TC4
	Left	Bottom	Right	Top
4WB	TC1	TC2	TC3	TC4

5-Wire Configurations



	Upper Right (Y-)	Upper Left (X-)	5 Wire Sense (5W)	Lower Left (Y+)	Lower Right (X+)
5WA	TC0	TC1	TC2	TC4	TC3
	LL	LR	5W	UL	UR
5WB	TC4	TC3	TC2	TC1	TC0

8-Wire Configurations



	Top (Y-)	Top Sense (SY-)	Bottom Sense (SY+)	Bottom (Y+)	Right (X+)	Right Sense (SX+)	Left Sense (XS-)	Left (X-)
8WA	TC1	S2	S0	TC4	TC0	TC3	S1	TC2
	Y-	SY-	SX-	X-	Y+	SY+	SX+	X+
8WB*	TC1	S2	S0	TC4	TC0	TC3	S1	TC2
	Y-	SY-	SY+	Y+	X+	X-	SX-	SX+
8WC	TC1	S2	S0	TC4	TC0	TC3	S1	TC2

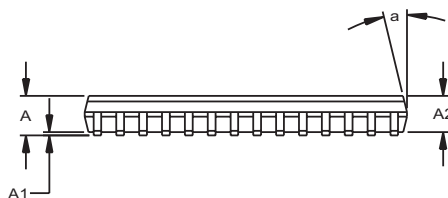
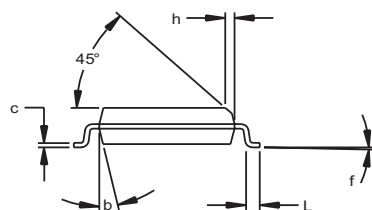
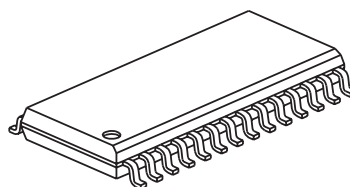
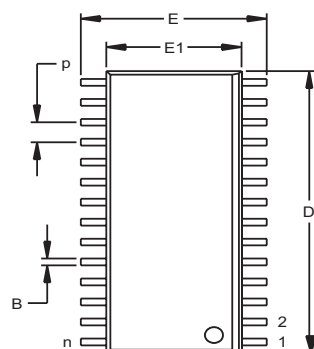
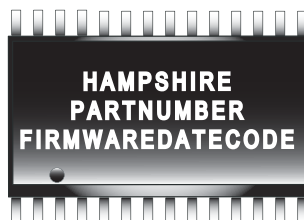
****The 8WB* pin out is the only valid 8-wire pin-out with the single multiplexor design.**

TSHARC-A2 28 Pin SOIC Mechanical Specification



TSHARC-A2 (12 - Bit) RS-232, USB, TTL Analog Resistive Touch Screen Microcontroller

TSHARC Industrial 4,5 and 8 wire analog resistive Touch Screen Microcontroller
28-Lead Plastic Small Outline (S) - 300mil (SOIC) mechanical specifications.



Units		INCHES*			MILLIMETERS		
Dimension	Limits	MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		28			28	
Pitch	p		.050			1.27	
Overall Height	A	.093	.099	.104	2.36	2.50	2.64
Molded Package Thickness	A2	.088	.091	.094	2.24	2.31	2.39
Standoff	A1	.004	.008	.012	0.10	0.20	0.30
Overall Width	E	.394	.407	.420	10.01	10.34	10.67
Molded Package Width	E1	.288	.295	.299	7.32	7.49	7.59
Overall Length	D	.695	.704	.712	17.65	17.87	18.08
Chamfer Distance	h	.010	.020	.029	0.25	0.50	0.74
Foot Length	L	.016	.033	.050	0.41	0.84	1.27
Foot Angle Top	f	0	4	8	0	4	8
Lead Thickness	c	.009	.011	.013	0.23	0.28	0.33
Lead Width	B	.014	.017	.020	0.36	0.42	0.51
Mold Draft Angle Top	a	0	12	15	0	12	15
Mold Draft Angle Bottom	b	0	12	15	0	12	15

*Controlling Parameter

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MS-013

Drawing No. C04-052

Please contact Hampshire Company for complete engineering specifications.

www.hampshirecompany.com Phone (US) 414-355-4675

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TSHARC-A2 Schematic / Bill of Material Reference Matrix

TSHARC Chip Model: TSHARC-A2
Resolution: 12 Bit
Available chips packages: 28 pin SOIC Industrial rated
Reference Controller Board: TSHARC-12D "Devil Ray" board
Schematic: See applicable schematic located in this document
Communication: Auto-detect RS-232 and USB. TTL also available
Touch Screens Supported: Auto-detect all manufacturer's 4, 5 and 8 wire analog resistive touch screens.
*BOM and Schematics may be implemented with a 3.3V or 5V A0 chip product.

Document	4-wire	5-wire	8-wire	RS-232	USB	TTL	Ex Clock
SB-501020	X	X	X	X	X	X	X
SB-502020		X		X	X	X	X
SB-503020	X	X	8WB Only	X	X	X	X



The schematics available are tested designs created by Microchip Technology, Inc. Special attention has been taken to optimize the performance of the touch controller circuitry in these designs. Different configurations of the existing design are available, as shown in the various published schematics. Any deviations from any of these designs may impact the overall implemented design in a negative way. Microchip Technology, Inc. does not recommend any changes or deviations from what is shown within the published TSHARC schematics. Microchip Technology, Inc. offers free schematic reviews as a complimentary service to assist design teams in the integration of TSHARC touch controllers.

Application Notes

- 1) H2 touch screen connection header.
 - a. H2-A, H2-B, H2-C and H2-D are representations for connecting various touch screen constructions to H2
 - b. This header is used to connect variations of 4 or 5 wire sensors. Some or all may be designed into your circuit to ensure future flexibility to choose a variety of touch screen manufacturers touch screens. Recommendation: Design in as many of these as you can. See Microchip's reference "Devil Ray" controller board or contact Microchip sales engineer to find ideas how you may maximize your touch screen compatibility matrix.

- 2) Make sure to keep all analog circuits away from high power and inverter circuits traces. Failure to follow this guideline will reduce your controller performance and/or accuracy.

- 3) Please contact Microchip Technology Inc. to ensure that you have the latest schematic and Bill of Material before proceeding with your final design. While Microchip cannot accept any responsibility for your final design, it is recommended that you contact Microchip support via telephone or via the support web page before proceeding with your production.

Also, to ensure our ability to support your embedded application of the TSHARC touch screen controller chip we ask that you send us a copy of your touch screen controller schematics drawings for your customer file. This is helpful if you require support sometime in the future. We offer this review service free of charge with any of our controller chips. Microchip does not share this information with any third party.

Phone: 414-355-4675

Email: <http://support.microchip.com>

- 4) A .22uF, or larger, capacitor must be tied to Pin 14 of the chip.
- 5) Please tie Pin 1 of all designs to VCC through a 10k Ohm resistor. This is for future development, should the hardware enable/disable functionality be included in your customer firmware set. Pulling this pin to VCC will prevent any errors from occurring in such a case.
- 6) Jumper 4 and Jumper 5 are used for the hardware EEPROM clear. To use this feature, both jumpers must be tied to ground at the boot of the chip. If both J4 and J5 are tied to ground at boot, then the controller will write FF to every byte of the EEPROM. This restores the chip to factory defaults. There are weak internal pull-ups. If not using this feature, leave these jumpers as floating points.
- 7) For USB only implementation, please ground TXD on the chip to ensure proper auto-detection of communication
- 8) Tx and Rx are noted as host-centric in the schematics. Tx is the transmit of the host, and Rx is the receive for the host.
- 9) The microcontroller requires a 5 Volt source for the regulator to supply the adequate 3.3 volts for operation. For proper USB operation, there must be 3.3 Volts supplied to VUSB. If not using 5 Volts supplied to the regulator, then 3.3 Volts must be supplied at Pin 14 of the chip.
- 10) If running the chip at 5 Volts, the 3.3 Volts supplied on Pin 14 of the chip cannot be used as a voltage source. This is the output from the regulator.
- 11) Pin 7 of the chip is used for MUX selection. This MUX signal is used in Microchip auto-detection and sampling routines. This pin is driven both high and low, and should remain floating if not implemented.
- 12) J1, J2, and J3 can be configured for custom jumper-selectable options. By default these pins are ignored and should be tied to VCC. Communication types, screen types, emulation, and Baud rates can be configured using these jumpers. Please contact Microchip Technology Inc. for available jumper configurations and compatible firmware.

Auto-Detect all 4, 5, and 8 wire A/R touch screens and RS-232 and USB



Bill of Materials B-501020
Auto-Detect all 4, 5, and 8 wire A/R touch screens and RS-232 and USB

Date: 02-05-08

Subject: TSHARC - Devil Ray LAYOUT and BOM

By: Hampshire Company, Inc.

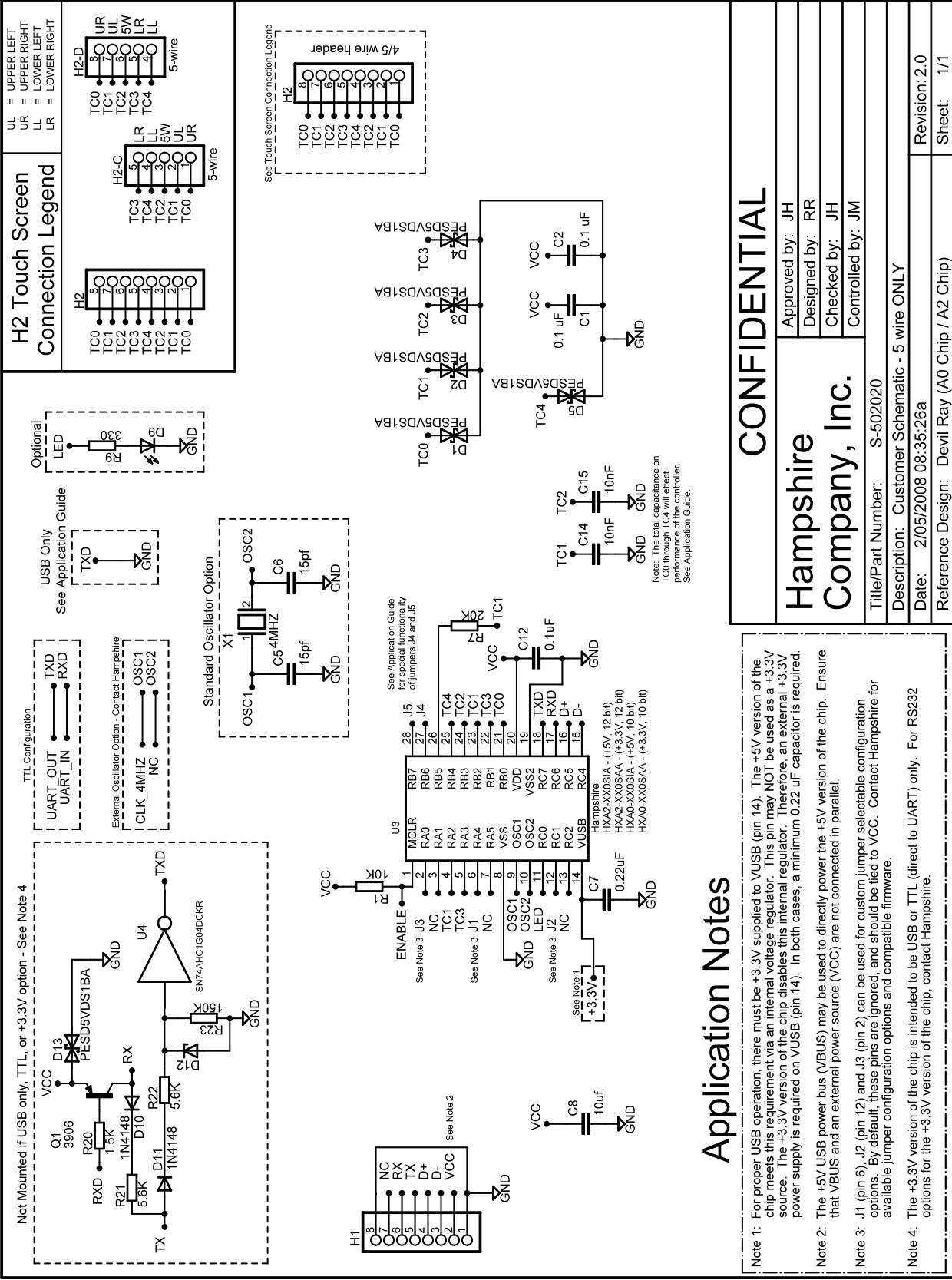
Date 02-05-08
Part Number: HS1X-Boardd-XX
Artwork: TD011408
Version: 2.0
Schematic: S-501020
BOM: B-501020

CONFIDENTIAL

BOM Table

Part	Qty	Value	Unit	Manufacturers Part#	Price	Description
C1 C2 C10 C11 C12	5	0.1	uF	Panasonic: ECJ-1VB1E104K or equivalent		CAP .1UF 25V CERAMIC X7R 0603
C5 C6	2	15	pf	Panasonic: ECJ-1VC1H150J or equivalent		CAP CERAMIC 15PF 5% 50V C0G 0603
C7	1	220	nf	AVX: 0603ZC224KAT2A or equivalent		CAP CERM .22UF 10% 10V X7R 0603
C8	1	10	uF	Murata: GRM21BR70J106KE76L or equivalent		CAP CER 10UF 6.3V X7R 0805
C14 C15	2	0.01	uF	AVX: 06035C103KAT2A or equivalent		CAP CERM .01UF 10% 50V X7R 0603
R1	1	10K	ohm	Yageo America: RC0603JR-0710KL or equivalent		RES 10K OHM 1/10W 5% 0603 SMD
R7	1	20.0K	ohm	Yageo America: RC0603JR-0720KL or equivalent		RES 20K OHM 1/10W 5% 0603 SMD
R9	1	330	ohm	Yageo America: RC0603JR-07330RL or equivalent		RES 330 OHM 1/10W 5% 0603 SMD
R20	1	1.5K	ohm	Yageo America: RC0603JR-071K5L or equivalent		RES 1.5K OHM 1/10W 5% 0603 SMD
R21 R22	2	5.6K	ohm	Yageo America: RC0603JR-075K6L or equivalent		RES 5.6K OHM 1/10W 5% 0603 SMD
R23	1	150K	ohm	Yageo America: RC0603JR-07150KL or equivalent		RES 150K OHM 1/10W 5% 0603 SMD
D1 D2 D3 D4 D5 D6 D7 D8 D13	9			NXP: PESD5VDS1BA or equivalent		DIODE BIDIR ESD PROTECT SOD323
D9	1	LED		Lite-On: LTST-C190GKT or equivalent		LED GREEN CLEAR 0603 SMD
D10 D11	2	1N4148		Micro Commercial: 1N4148WX-TP or equivalent		DIODE SWITCH 75V 300MA SOD323
D12	1	Zener		Diodes Inc: MMSZ5231BS-7-F or equivalent		DIODE ZENER 5.1V 200MW SOD-323
Q1	1	3906		Fairchild: MMBT3906 or equivalent		TRANSISTOR GP PNP AMP SOT-23
X1	1	4	MHZ	Abracon: ABC2-4.000MHZ-D or Citizen: CS20-4.000MAJ-UT or equivalent		CRYSTAL 4.000MHZ SMD
U1 U2	2	74HC4052		Texas:CD74HC4052PWR or equivalent		IC ANALOG MUX/DEMUX HS 16-TSSOP
U3	1			Hampshire: HSAX-040SIA (for alternate configurations, contact Hampshire)		28 pin SOIC. This RoHS compliant IC will be supplied by Hampshire
U4	1	NC7WZ04		Fairchild: NC7WZ04P6X or equivalent		IC INVERTER UHS DUAL HS SC70-6

Schematic S-502020
5 wire only, A/R touch screens AutoDetect RS-232 and USB



Bill of Materials B-502020
5 wire only A/R touch screens AutoDetect RS-232 and USB

Date: 02-05-08

Subject: TSHARC - Devil Ray LAYOUT and BOM

By: Hampshire Company, Inc.

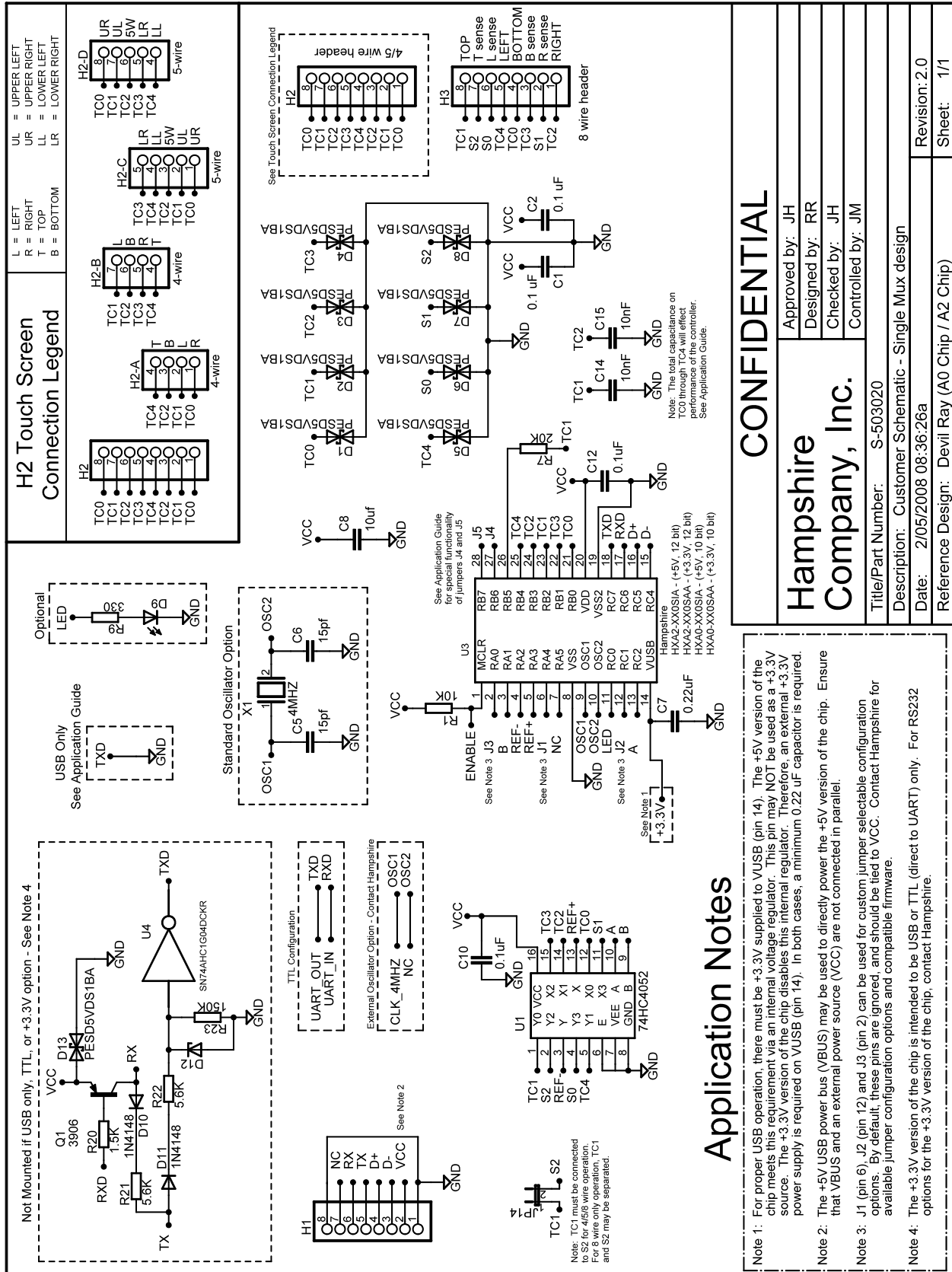
Date 02-05-08
Part Number: HS1X-Boardd-XX
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CONFIDENTIAL

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R9	1	330	ohm	Yageo America: RC0603JR-07330RL or equivalent		RES 330 OHM 1/10W 5% 0603 SMD
R20	1	1.5K	ohm	Yageo America: RC0603JR-071K5L or equivalent		RES 1.5K OHM 1/10W 5% 0603 SMD
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R23	1	150K	ohm	Yageo America: RC0603JR-07150KL or equivalent		RES 150K OHM 1/10W 5% 0603 SMD
D1 D2 D3 D4 D5 D13	6			NXP: PESD5VDS1BA or equivalent		DIODE BIDIR ESD PROTECT SOD323
D9	1	LED		Lite-On: LTST-C190GKT or equivalent		LED GREEN CLEAR 0603 SMD
D10 D11	2	1N4148		Micro Commercial: 1N4148WX-TP or equivalent		DIODE SWITCH 75V 300MA SOD323
D12	1	Zener		Diodes Inc: MMSZ5231BS-7-F or equivalent		DIODE ZENER 5.1V 200MW SOD-323
Q1	1	3906		Fairchild: MMBT3906 or equivalent		TRANSISTOR GP PNP AMP SOT-23
X1	1	4	MHZ	Abracon: ABC2-4.000MHZ-D or Citizen: CS20-4.000MAJ-UT or equivalent		CRYSTAL 4.000MHZ SMD
U3	1			Hampshire: HSAX-040SIA (for alternate configurations, contact Hampshire)		28 pin SOIC. This RoHS compliant IC will be supplied by Hampshire
U4	1	SN74AHC1G		Texas: SN74AHC1G04DCKR		IC SINGLE INVERTER GATE SC70-5

Auto-Detect all 4 and 5 wire screens and 8WB A/R touch screens and RS-232 and USB



Bill of Materials B-503020**Auto-Detect all 4 and 5 wire screens and 8WB A/R touch screens and RS-232 and USB**

Date: 02-05-08

Subject: TSHARC - Devil Ray LAYOUT and BOM

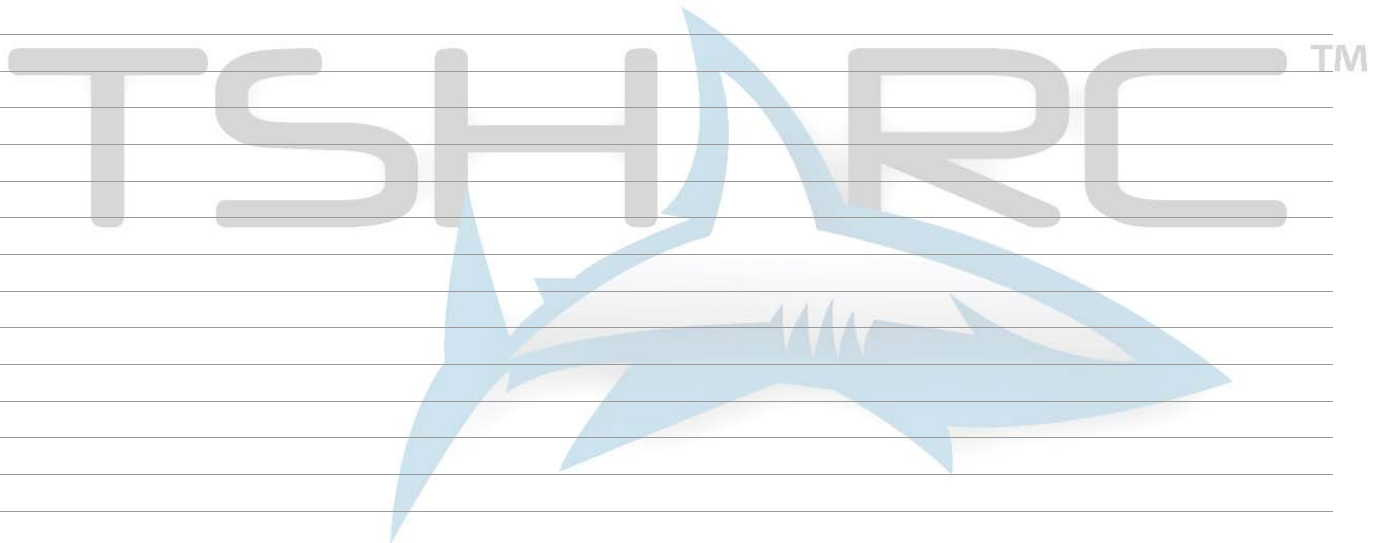
By: Hampshire Company, Inc.

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R9	1	330	ohm	Yageo America: RC0603JR-07330RL or equivalent		RES 330 OHM 1/10W 5% 0603 SMD
R20	1	1.5K	ohm	Yageo America: RC0603JR-071K5L or equivalent		RES 1.5K OHM 1/10W 5% 0603 SMD
R21 R22	2	5.6K	ohm	Yageo America: RC0603JR-075K6L or equivalent		RES 5.6K OHM 1/10W 5% 0603 SMD
R23	1	150K	ohm	Yageo America: RC0603JR-07150KL or equivalent		RES 150K OHM 1/10W 5% 0603 SMD
D1 D2 D3 D4 D5 D6 D7 D8 D13	9			NXP: PESD5VDS1BA or equivalent		DIODE BIDIR ESD PROTECT SOD323
D9	1	LED		Lite-On: LTST-C190GKT or equivalent		LED GREEN CLEAR 0603 SMD
D10 D11	2	1N4148		Micro Commercial: 1N4148WX-TP or equivalent		DIODE SWITCH 75V 300MA SOD323
D12	1	Zener		Diodes Inc: MMSZ5231BS-7-F or equivalent		DIODE ZENER 5.1V 200MW SOD-323
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U4	1	SN74AHC1G		Texas: SN74AHC1G04DCKR		IC SINGLE INVERTER GATE SC70-5

Notes



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