

Mux3: Bus Switch using PCA9545

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Contents

| | | |
|----------|--|----------|
| 1 | Introduction | 1 |
| 1.1 | Why use a Bus Switch | 2 |
| 1.2 | Features of MUX3 Bus Switch Module | 2 |
| 1.3 | Features of PCA9545 | 3 |
| 2 | Module Details | 3 |
| 2.1 | Power On State | 3 |
| | Power Drain | 4 |
| 2.2 | \overline{RESET} Input | 4 |
| | Controlling with I2C2PC | 4 |
| 2.3 | IRQ inputs | 4 |
| 2.4 | Downstream VDD and Level Shifting | 4 |
| | Isolating Downstream VDD | 5 |
| 2.5 | Slave Address | 5 |
| 2.6 | PCB Revisions | 5 |
| | Rev 0 | 5 |
| | Rev 1 | 5 |
| 3 | Schematics and Drawings | 5 |

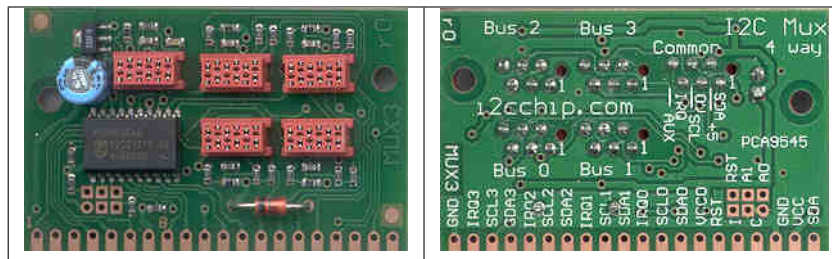
1 Introduction

The PCA9545A is a quad bidirectional translating switch controlled via the I2C bus. The SCL/SDA upstream pair fans out to four downstream pairs, or channels. Any individual SCn/SDn channel or combination of channels can be selected, determined by the contents of the programmable control register. Four interrupt inputs (INT3-INT0), one for each of the downstream pairs, are provided. One interrupt (INT) output acts as an AND of the four interrupt inputs.

An active-low reset (RESET) input allows the PCA9545A to recover from a situation in which one of the downstream I2C buses is stuck in a low

state. Pulling RESET low resets the I2C state machine and causes all the channels to be deselected, as does the internal power-on reset function.

The pass gates of the switches are constructed such that the VCC pin can be used to limit the maximum high voltage, which will be passed by the PCA9545A. This allows the use of different bus voltages on each pair, so that 1.8-V, 2.5-V, or 3.3-V parts can communicate with 5-V parts, without any additional protection. External pullup resistors pull the bus up to the desired voltage level for each channel. All I/O pins are 5.5-V tolerant.¹



1.1 Why use a Bus Switch

There are several reasons to use this Bus Switch Module in a system

- More ports to use with more chips that have the same address.
- To build up large systems with lots of the same chip, e.g. a large array of temperature sensors.
- Where excessive bus capacitance is slowing the bus down, it allows the bus to be broken into smaller pieces. Similarly when one segment of the bus has a long cable which requires low speed operation this can be isolated.
- Where low speed devices (e.g. software I2C slaves) are used, they can be isolated from high speed slaves to avoid slowing the whole bus down.
- Level Shifting: The PCA9545 will level shift. The module has a built in 3.3V regulator, so you can optionally run the switched ports at 3.3V or 5V when the main bus is 5V
- Fault Tolerance: Isolate faulty segments or to act as a sacrificial element to limit the extent of overvoltage damage.
- Hot Swapping: Isolate segments until connected.

1.2 Features of MUX3 Bus Switch Module

- Built in regulator for 3.3V level shifting if desired with jumper for voltage selection
- 4 Slave Addresses: up to 16 buses with a single level of switching.

¹TI.com description

- Standard I2C Micromatch connectors
- SIP connector to use as a daughter board
- External RESET input to force clear the switch.
- Power LED
- 2 mounting holes

1.3 Features of PCA9545

- A bus switch rather than a multiplexor, so you can have any combination of ports selected
- Has hardware reset pin. This means that a fault on one segment can be cleared without blocking the multiplexor.
- IRQ inputs as well as SDA & SCL. (note that IRQ's are inputs, and are not switched)
- Performs level shifting for bus voltages as low as 1.8V
- 2.3 - 5.5V operation.
- 2nd sourced: NXP and TI
- Possible to get 3 alternative slave address versions from NXP

2 Module Details

The silkscreen on the bottom of the pcb shows most pin names and jumper functions.

| Pin | Function | Pin | Function |
|-----|------------------|-----|----------|
| 1 | SDA Common | 11 | SDA1 |
| 2 | VCC In (common) | 12 | SCL1 |
| 3 | GND | 13 | IRQ1 In |
| 4 | SCL Common | 14 | SDA2 |
| 5 | IRQ Out (common) | 15 | SCL2 |
| 6 | RST In/AUX | 16 | IRQ2 In |
| 7 | VCC Out | 17 | SDA3 |
| 8 | SDA0 | 18 | SCL3 |
| 9 | SCL0 | 19 | IRQ3 In |
| 10 | IRQ0 In | 20 | GND |

2.1 Power On State

All switches are OFF at power up.

Power Drain

For very low standby power applications you can remove the power LED.

2.2 \overline{RESET} Input

Jumper 1-3 connects the external *ACTIVE LOW \overline{RESET}* to the PCA9545. The external reset is connected to the SIP pads and pin 6 (AUX) of the input micromatch.

The Reset input exists because the switch is controlled by the same bus that is connected to the slaves. So if there is a fault on any downstream bus that blocks the bus, then it becomes impossible to command the switch and disconnect that segment.

The reset input is not connected when supplied.

Controlling with I2C2PC

To control the Reset input from the I2C2PC adaptor you will need to link an unused control line (for example the CS2 pin, to the AUX pin (pin6) of one bus connector.

Then you control the reset line using the direct pin commands. See the BL233 datasheet and SPI application notes for more information. Realterm has buttons for controlling CS1 and CS2 pins.

2.3 IRQ inputs

The IRQ lines are not switched. They are inputs to a gate. If any IRQ input goes low, the IRQ output will go low. This allows interrupts to be sensed on disconnected bus segments.

By reading the bus switch STATUS byte you can check the IRQ pin states.

The IRQ lines cannot be used as CS outputs in an SPI system - they are inputs only.

2.4 Downstream VDD and Level Shifting

The module has a built in 3.3V, 200mA regulator which can be bypassed by L1/JP2. The default is L1/JP2 fitted, and downstream busses are at the main VDD voltage.

On Rev0 boards L1 must be removed to use the regulator. On Rev1, Jumper JP2 is used.

All downstream busses will be operating at the VDD voltage of the PCA9545. The PCA9545 acts as a level shifter, so the main bus can run at 5V and the downstream busses at 3.3V. By replacing IC2, you can use other voltages.

Isolating Downstream VDD

L2-L5 are zero ohm jumpers in series with VDD to each downstream port. You can replace them with PTC protection devices, filter inductors, or remove them completely where the device is self powered.

2.5 Slave Address

Slave Address is set by JP1-1, JP1-2

| Address | A0 | A1 |
|---------|--------|--------|
| 0xE0 | - | - |
| 0xE2 | fitted | - |
| 0xE4 | - | fitted |
| 0xE6 | fitted | fitted |

Alternative address versions of the chip are available from NXP, and could be supplied to special order. These would allow up to 12 switches or 48 downstreams per bus.

| Type | Base Address |
|----------|--------------|
| PCF9545A | 0xE0 |
| PCF9545B | 0xD0 |
| PCF9545C | 0xB0 |

2.6 PCB Revisions

Rev 0

VDD selection by removing component L1 (0603 package zero ohm link)

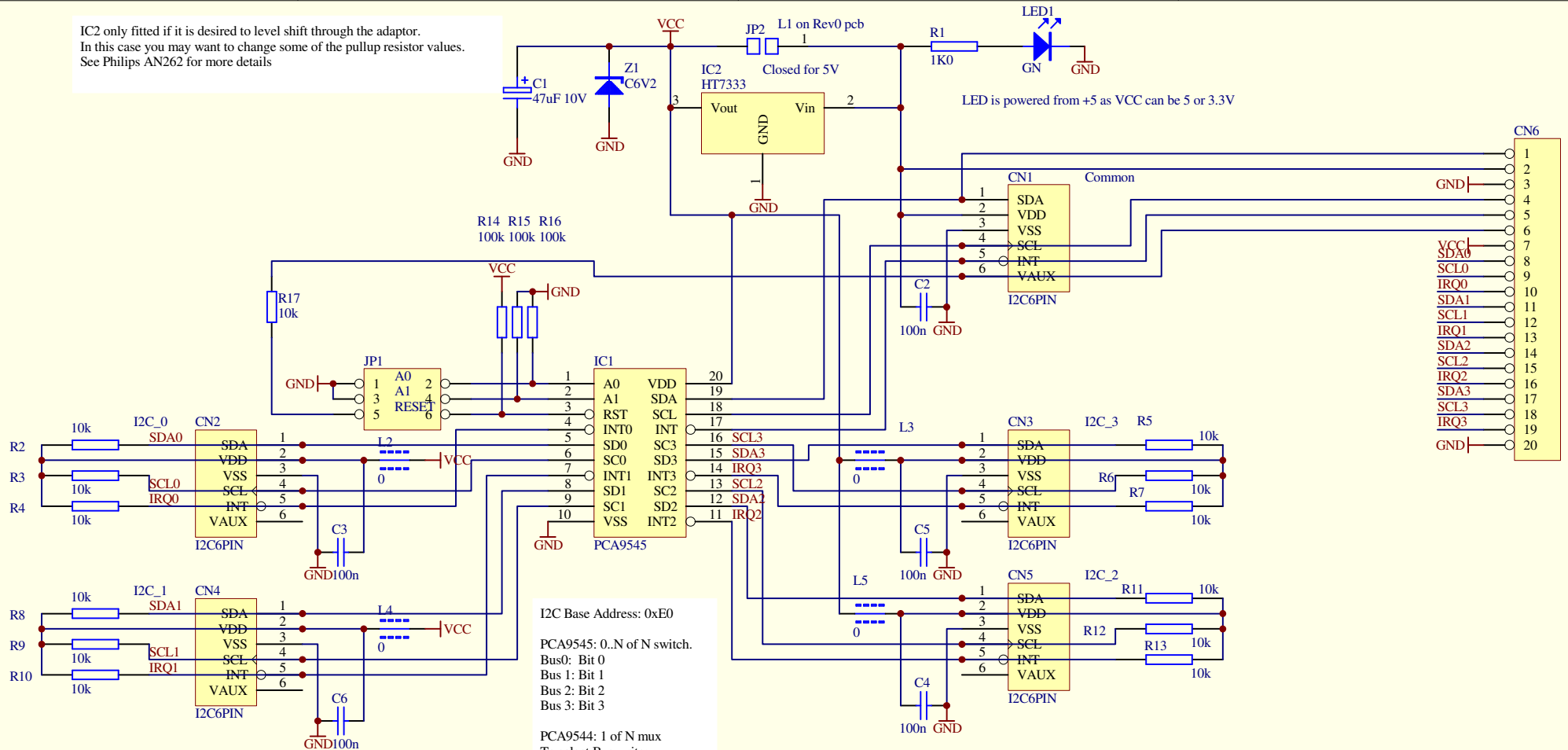
Rev 1

Mechanical dimensions unchanged. Electrical function unchanged.

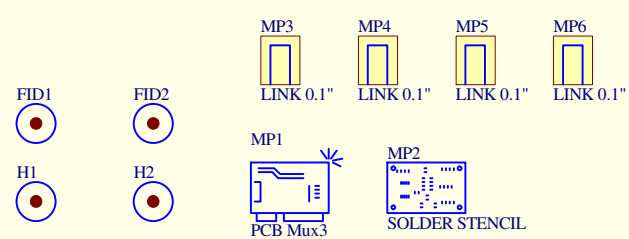
Uses TSSOP20 package IC. VDD selection jumper JP2 fitted instead of 0603 jumper L2

3 Schematics and Drawings

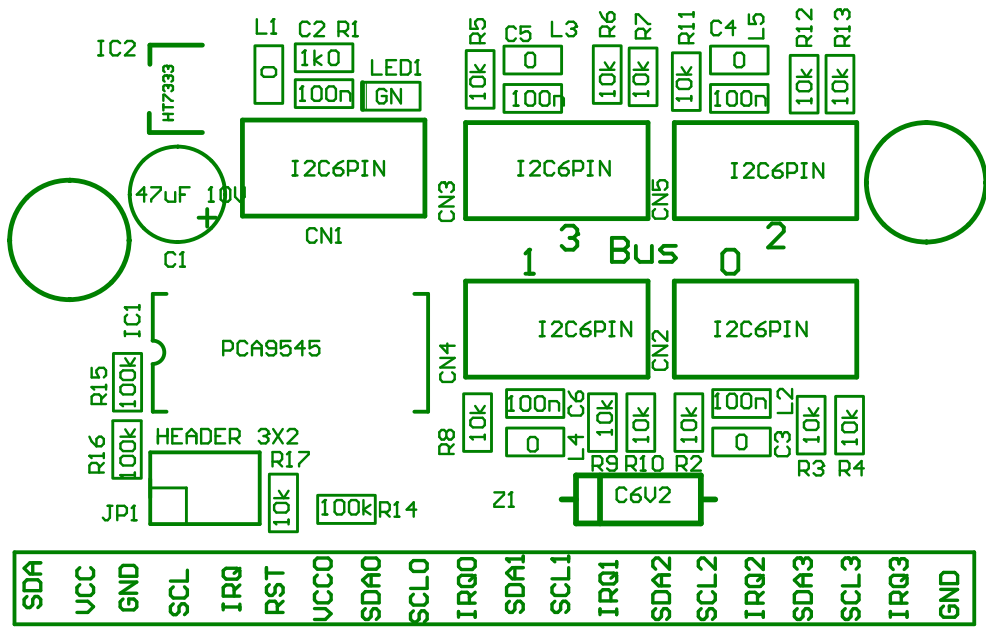
IC2 only fitted if it is desired to level shift through the adaptor.
 In this case you may want to change some of the pullup resistor values.
 See Philips AN262 for more details

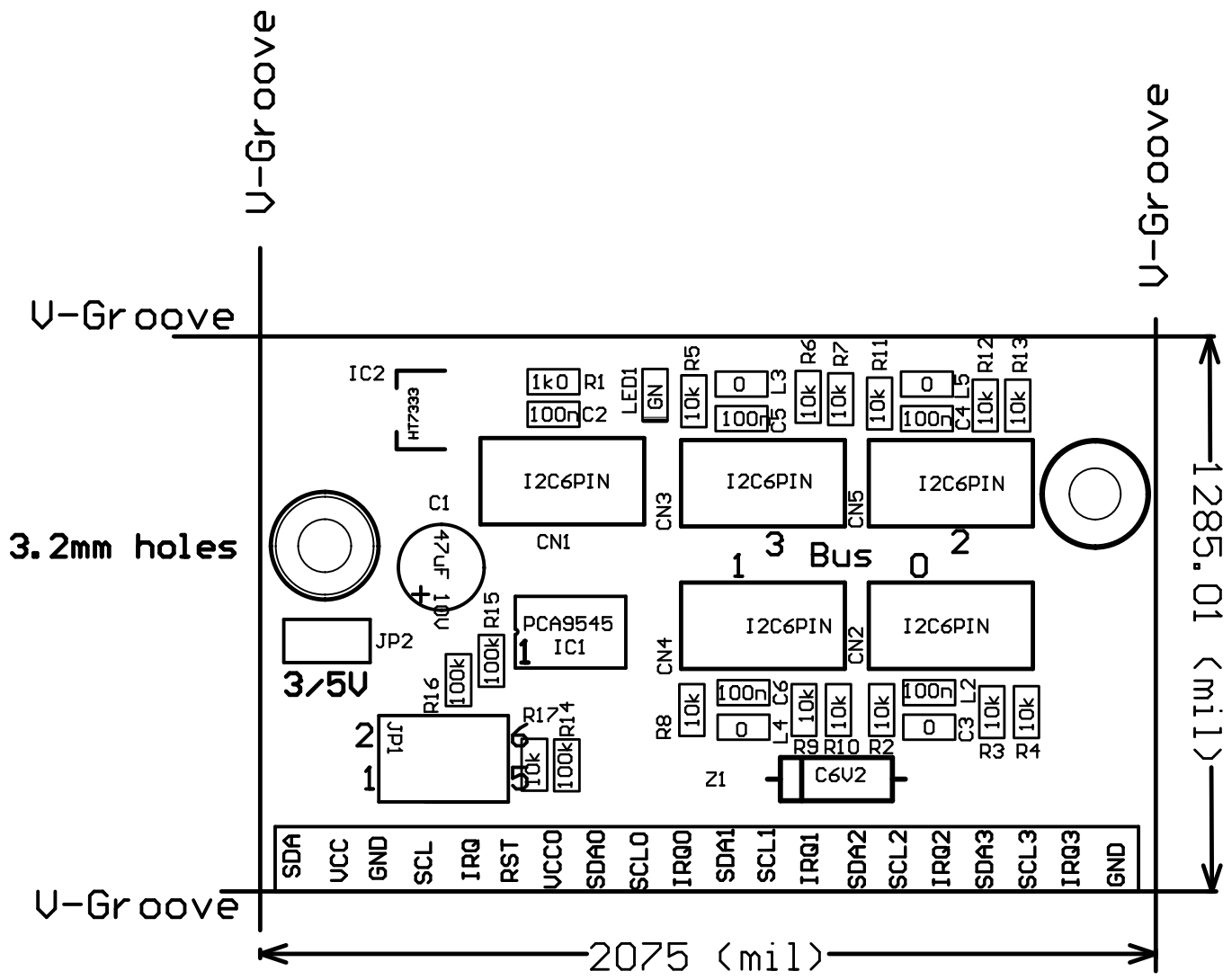


I2C Base Address: 0xE0
 PCA9545: 0..N of N switch.
 Bus 0: Bit 0
 Bus 1: Bit 1
 Bus 2: Bit 2
 Bus 3: Bit 3
 PCA9544: 1 of N mux
 To select Bus write:
 Bus 0: 04
 Bus 1: 05
 Bus 2: 06
 Bus 3: 07
 All Off: 00

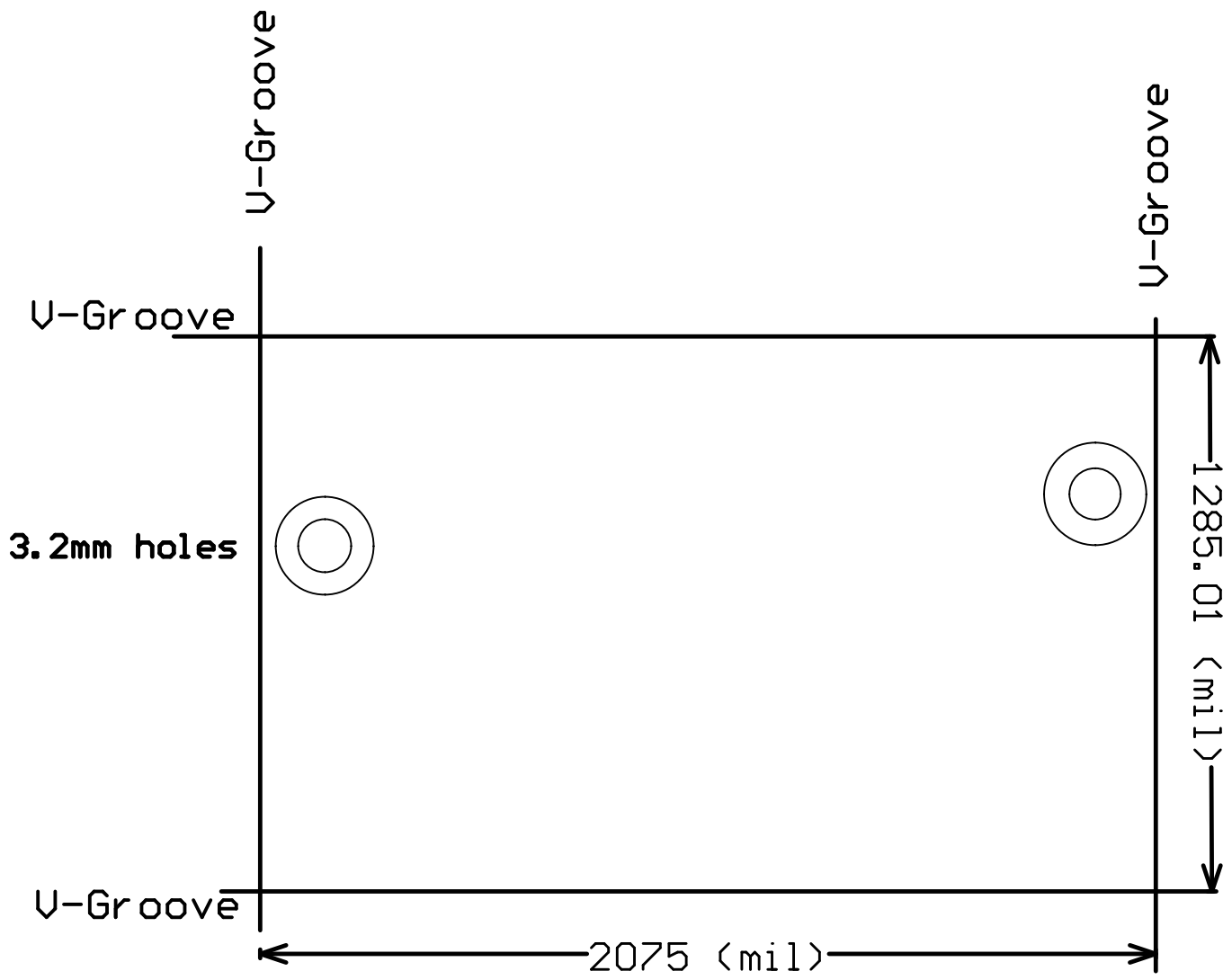


| | | |
|-------|------------------------|-----------|
| Title | | |
| Size | Number | Revision |
| A4 | | |
| Date: | 17-Oct-2007 | Sheet of |
| File: | C:\cad\I2CAd\I2CAd.ddb | Drawn By: |





Silk Screen: Bottom Overlay only
Plated Through Holes



Silk Screen: Bottom Overlay only
Plated Through Holes