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## Atmel AVR600: STK600 Expansion, Routing and Socket Boards

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### Atmel Microcontrollers

#### Introduction

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This application note describes the process of developing new routing, socket and expansion cards for the Atmel STK®600. It also describes the physical parameters for creating such cards.

The STK600 starter kit from Atmel has a sandwich design to match a specific part package and pin out to the generic pin headers. It also features an expansion area where most part pins are available.

While the variety of IC packages is relatively limited, the number of possible pinouts increases rapidly with the number of pins. I.e. a 6-pin IC can have 720 (6!) different pinouts!

The routing / socket card design provides a lowcost solution to support upcoming devices as the socket is the cost driving factor.

STK600 users might also want to create their own routing cards to include specialized hardware to prototype their own design.

**Figure 1. STK600 router and socket card.**



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# 1. Routing Cards

The routing cards sit between the generic socket card and the Atmel STK600. It has one pair of electric pads underneath to mate with the STK600 spring loaded connector, and one pair of pads on top where the socket card connector connects. A part specific card with the target IC soldered on can be viewed as a routing card without the top pads.

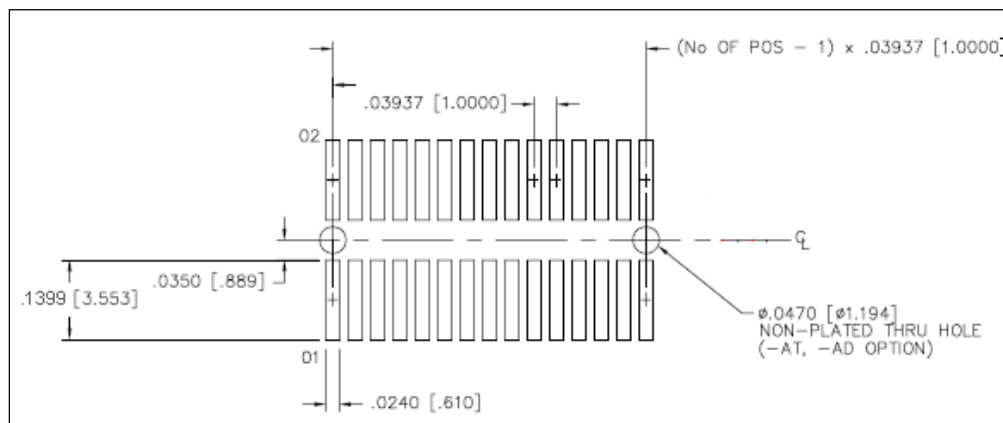
## 1.1 Connector footprints

A routing card should have pads to mate with the following spring loaded connectors:

**Table 1-1. Router card connectors.**

| Manufacturer and MPN      | Quantity | Comment                      |
|---------------------------|----------|------------------------------|
| SAMTEC, FSI-140-03-G-D-AD | 2        | 80-pins to socket card (top) |
| SAMTEC, FSI-150-03-G-D-AD | 2        | 100-pins to STK600 (bottom)  |

**Figure 1-1. PCB land pattern for mating to FSI connectors.**



## 1.2 Physical dimensions and component placement

Figure 1-2. Routing card connector pad placement and dimensions.

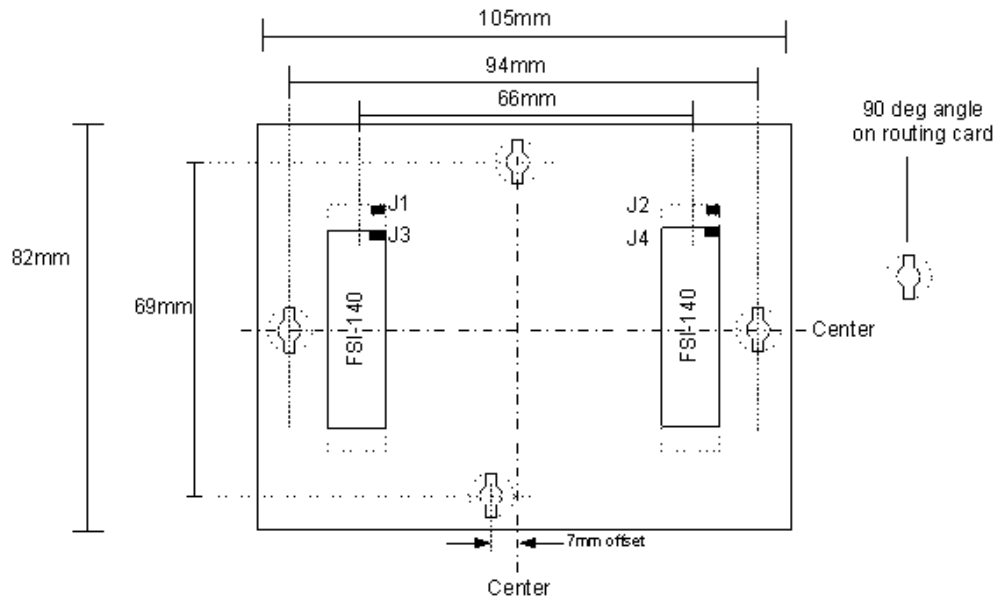
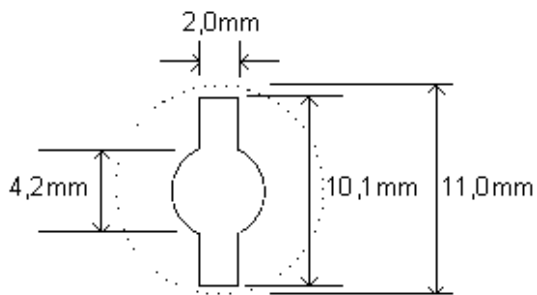


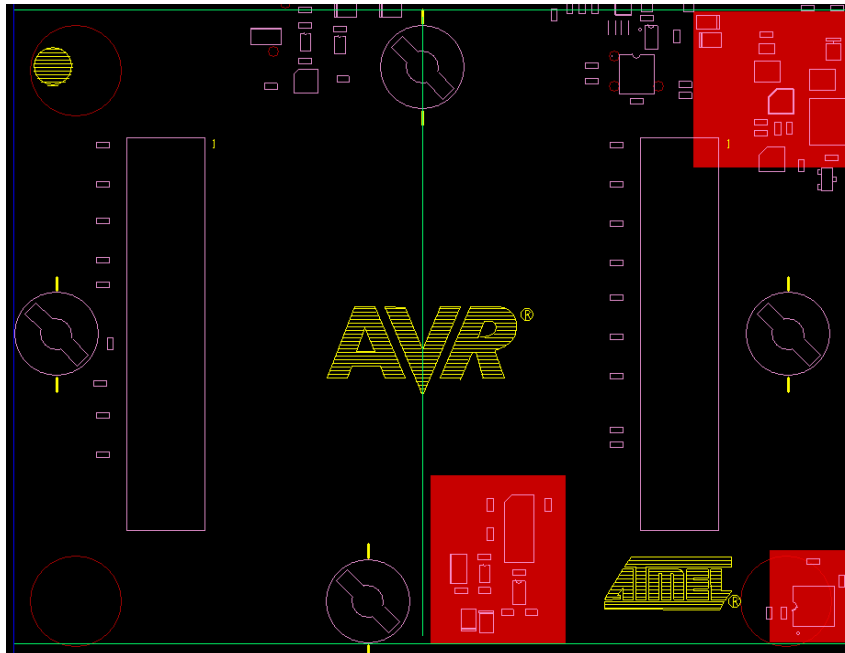
Figure 1-3. Clip hole dimensions.



The board thickness should be 1.6mm to be compatible with the clips.

Note: Components on the main board might conflict with through hole mounted or secondary side mounted components. Areas with such components are highlighted in [Figure 1-4](#).

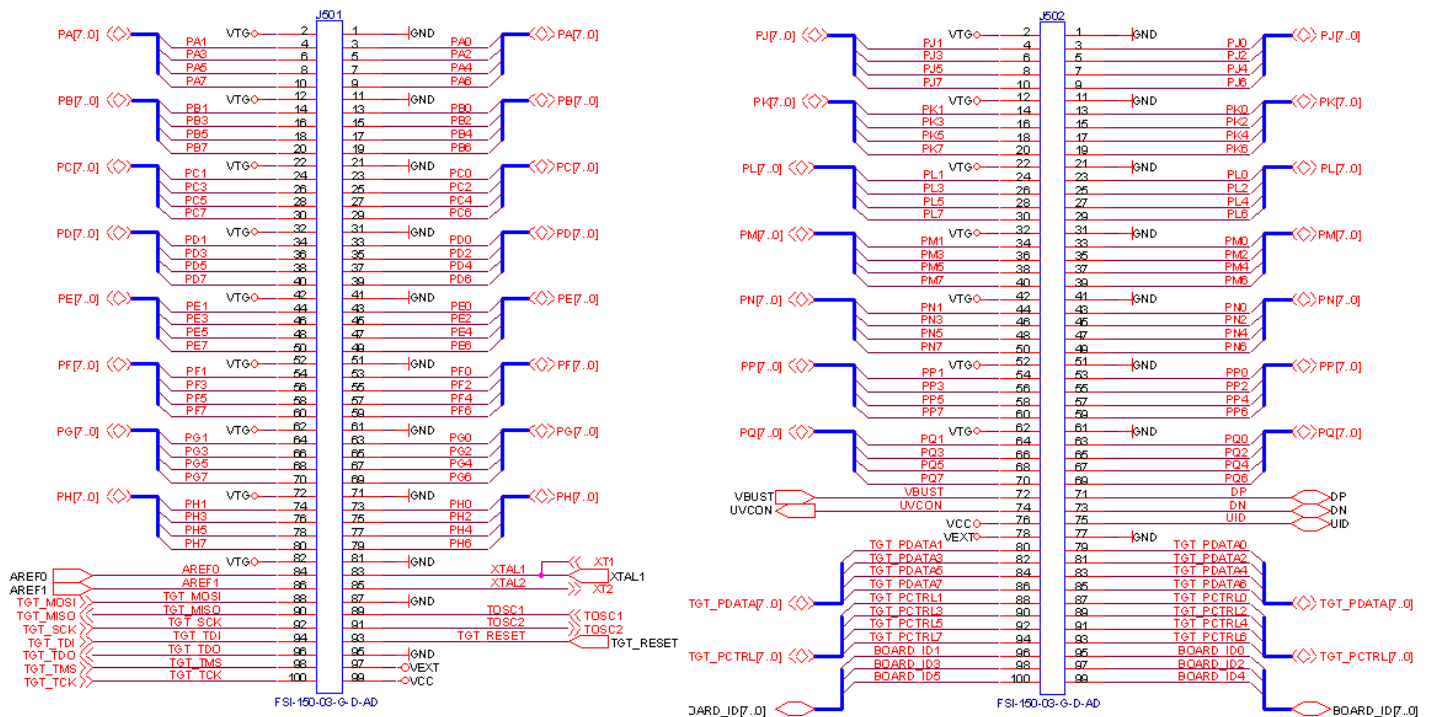
Figure 1-4. Height restricted areas due to main board components.



### 1.3 Atmel STK600 socket connectors pinout

Figure 1-5 shows the pinout for the STK600 headers. This corresponds to the routing card connectors J1 and J2.

Figure 1-5. STK600 socket connectors' pinout.



**Table 1-2. Atmel STK600 J201 left, routing card connector J1 pinout.**

| Signal name | Pin number |    | Signal name |
|-------------|------------|----|-------------|
| VTG         | 2          | 1  | GND         |
| PA1         | 4          | 3  | PA0         |
| PA3         | 6          | 5  | PA2         |
| PA5         | 8          | 7  | PA4         |
| PA7         | 10         | 9  | PA6         |
| VTG         | 12         | 11 | GND         |
| PB1         | 14         | 13 | PB0         |
| PB3         | 16         | 15 | PB2         |
| PB5         | 18         | 17 | PB4         |
| PB7         | 20         | 19 | PB6         |
| VTG         | 22         | 21 | GND         |
| PC1         | 24         | 23 | PC0         |
| PC3         | 26         | 25 | PC2         |
| PC5         | 28         | 27 | PC4         |
| PC7         | 30         | 29 | PC6         |
| VTG         | 32         | 31 | GND         |
| PD1         | 34         | 33 | PD0         |
| PD3         | 36         | 35 | PD2         |
| PD5         | 38         | 37 | PD4         |
| PD7         | 40         | 39 | PD6         |
| VTG         | 42         | 41 | GND         |
| PE1         | 44         | 43 | PE0         |
| PE3         | 46         | 45 | PE2         |
| PE5         | 48         | 47 | PE4         |
| PE7         | 50         | 49 | PE6         |
| VTG         | 52         | 51 | GND         |
| PF1         | 54         | 53 | PF0         |
| PF3         | 56         | 55 | PF2         |
| PF5         | 58         | 57 | PF4         |
| PF7         | 60         | 59 | PF6         |
| VTG         | 62         | 61 | GND         |
| PG1         | 64         | 63 | PG0         |
| PG3         | 66         | 65 | PG2         |
| PG5         | 68         | 67 | PG4         |
| PG7         | 70         | 69 | PG6         |
| VTG         | 72         | 71 | GND         |
| PH1         | 74         | 73 | PH0         |
| PH3         | 76         | 75 | PH2         |
| PH5         | 78         | 77 | PH4         |

|          |     |    |           |
|----------|-----|----|-----------|
| PH7      | 80  | 79 | PH6       |
| VTG      | 82  | 81 | GND       |
| AREF0    | 84  | 83 | XTAL1     |
| AREF1    | 86  | 85 | XTAL2     |
| TGT_MOSI | 88  | 87 | GND       |
| TGT_MISO | 90  | 89 | TOSC1     |
| TGT_SCK  | 92  | 91 | TOSC2     |
| TDI      | 94  | 93 | TGT_RESET |
| TDO      | 96  | 95 | GND       |
| TMS      | 98  | 97 | Vext      |
| TCK      | 100 | 99 | Vcc       |

**Table 1-3. Atmel STK600 J202 right, routing card connector J2 pinout.**

| Signal name | Pin number |    | Signal name |
|-------------|------------|----|-------------|
| VTG         | 2          | 1  | GND         |
| PJ1         | 4          | 3  | PJ0         |
| PJ3         | 6          | 5  | PJ2         |
| PJ5         | 8          | 7  | PJ4         |
| PJ7         | 10         | 9  | PJ6         |
| VTG         | 12         | 11 | GND         |
| PK1         | 14         | 13 | PK0         |
| PK3         | 16         | 15 | PK2         |
| PK5         | 18         | 17 | PK4         |
| PK7         | 20         | 19 | PK6         |
| VTG         | 22         | 21 | GND         |
| PL1         | 24         | 23 | PL0         |
| PL3         | 26         | 25 | PL2         |
| PL5         | 28         | 27 | PL4         |
| PL7         | 30         | 29 | PL6         |
| VTG         | 32         | 31 | GND         |
| PM1         | 34         | 33 | PM0         |
| PM3         | 36         | 35 | PM2         |
| PM5         | 38         | 37 | PM4         |
| PM7         | 40         | 39 | PM6         |
| VTG         | 42         | 41 | GND         |
| PN1         | 44         | 43 | PN0         |
| PN3         | 46         | 45 | PN2         |
| PN5         | 48         | 47 | PN4         |
| PN7         | 50         | 49 | PN6         |
| VTG         | 52         | 51 | GND         |
| PP1         | 54         | 53 | PP0         |

|            |     |    |            |
|------------|-----|----|------------|
| PP3        | 56  | 55 | PP2        |
| PP5        | 58  | 57 | PP4        |
| PP7        | 60  | 59 | PP6        |
| VTG        | 62  | 61 | GND        |
| PQ1        | 64  | 63 | PQ0        |
| PQ3        | 66  | 65 | PQ2        |
| PQ5        | 68  | 67 | PQ4        |
| PQ7        | 70  | 69 | PQ6        |
| VBUST      | 72  | 71 | DP         |
| UVCON      | 74  | 73 | DN         |
| Vcc        | 76  | 75 | UID        |
| Vext       | 78  | 77 | GND        |
| TGT_PDATA1 | 80  | 79 | TGT_PDATA0 |
| TGT_PDATA3 | 82  | 81 | TGT_PDATA2 |
| TGT_PDATA5 | 84  | 83 | TGT_PDATA4 |
| TGT_PDATA7 | 86  | 85 | TGT_PDATA6 |
| TGT_PCTRL1 | 88  | 87 | TGT_PCTRL0 |
| TGT_PCTRL3 | 90  | 89 | TGT_PCTRL2 |
| TGT_PCTRL5 | 92  | 91 | TGT_PCTRL4 |
| TGT_PCTRL7 | 94  | 93 | TGT_PCTRL6 |
| BOARD_ID1  | 96  | 95 | BOARD_ID0  |
| BOARD_ID3  | 98  | 97 | BOARD_ID2  |
| BOARD_ID5  | 100 | 99 | BOARD_ID4  |

### 1.3.1 Signal descriptions

**Table 1-4. Socket card connector pin description.**

| Atmel STK600 signal name           | MCU               | Comment   |
|------------------------------------|-------------------|---|
| PAx, PBx etc                       | PAx, PBx etc      | 1-to-1 MCU pin mapping  |
| VTG                                | Vcc               | Target supply rail controlled by Atmel AVR Studio® / STK600                                 |
| GND                                | GND               |   |
| AREF <sub>x</sub>                  | AREF              | Analog reference voltage, controlled by AVR Studio / STK600                                 |
| XTAL <sub>x</sub>                  | XTAL <sub>x</sub> | Clock pins connected to oscillator on STK600  |
| TGT_SCK, TGT_MISO, TGT_MOSI        | ISP pins          | ISP programming interface   |
| TGT_TDI, TGT_TDO, TGT_TMS, TGT_TCK | JTAG pins         | JTAG programming interface  |
| VBUST                              | VBUS              | VBUS (sense) for USB  |
| UID                                | UID               | ID pin for USB OTG  |
| UVCON                              | UVCON             | USB VBUS generation control for USB OTG. A low level on this signal enables VBUS generation |
| DP, DN                             | DP, DN            | USB differential pair   |
| TGT_PDATA(0-7)                     | (HV) data pins    | Data pins for high voltage (PP/HVSP) programming  |



|           |                 |   |
|-----------|-----------------|---|
| TGT_CTRL0 | (HV) BS2        | Control signals for High voltage Parallel Programming / Serial Programming. Refer to AVR datasheet for further information.<br>On AVR with common XA1/BS2, XA1 is used.<br>On AVR with common BS1/PAGEL, BS1 is used. |
| TGT_CTRL1 | (HV) Ready/Busy |   |
| TGT_CTRL2 | (HV) /OE        |   |
| TGT_CTRL3 | (HV) /WR        |   |
| TGT_CTRL4 | (HV) BS1        |   |
| TGT_CTRL5 | (HV) XA0        |   |
| TGT_CTRL6 | (HV) XA1        |   |
| TGT_CTRL7 | (HV) PAGEL      |   |
| BOARD_IDn | none            | ID system for router / socket / expansion cards, see <a href="#">Chapter 4 - ID System</a>  |

- Notes:
1. Not all AVR will have every pin (ex. two aref pins, tosc or usb).
  2. A MCU pin will fan-out to both Pnx pin and to the programming interface(s) located at that pin.

## 2. Socket Cards

Socket cards route each pin from the IC socket to separate pins on the spring loaded connectors on the bottom side, facing the routing card.

### 2.1 Power design issues

As all routing is handled by the routing card, even power lines and power decoupling is ignored at the socket card. This produces less than ideal power design, which may lead to unwanted noise, ground bounce, and other effects. It should therefore be expected that heavily loaded designs cannot run at full speed on the Atmel STK600. Likewise, such power design is not recommended for custom designs.

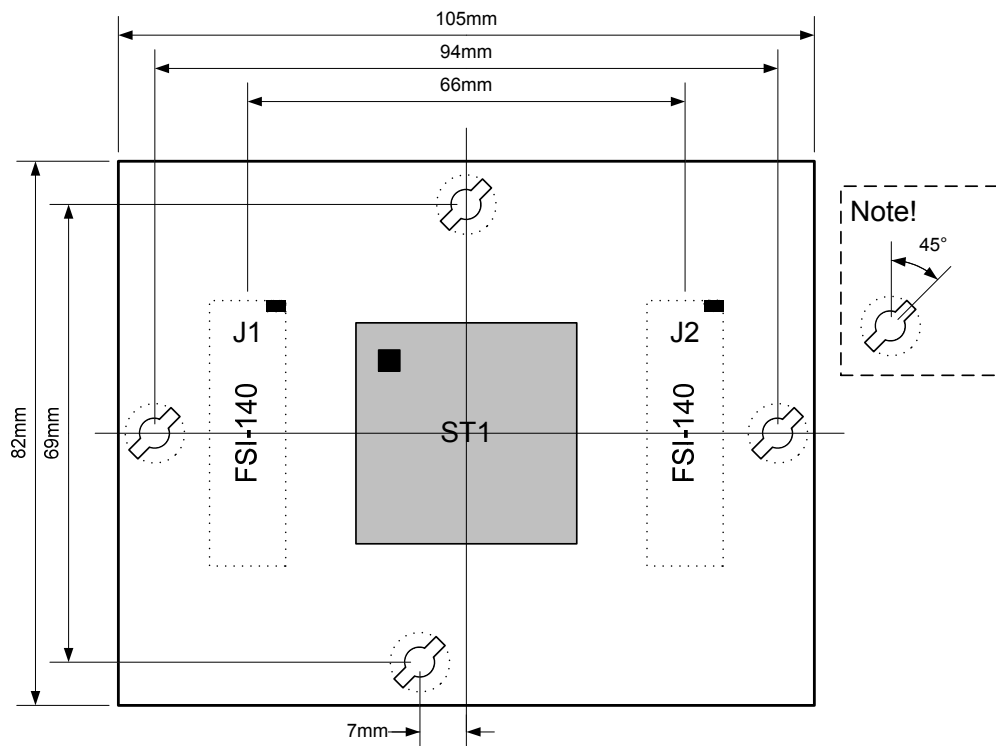
### 2.2 Connector MPN

Table 2-1. Socket card connector.

| Manufacturer and MPN      | Quantity | Comment                        |
|---------------------------|----------|--------------------------------|
| SAMTEC, FSI-140-03-G-D-AD | 2        | Spring loaded 80-pin connector |

### 2.3 Physical dimensions and component placement

Figure 2-1. Socket card connector placement and dimensions.



The board thickness should be 1.6mm to be compatible with the clips.

### 3. Expansion Cards

The Atmel STK600 features an expansion area where cards for custom peripherals like memory expansion, LCD etc can be placed. STK600 routes all part pins and power to the expansion card connectors.

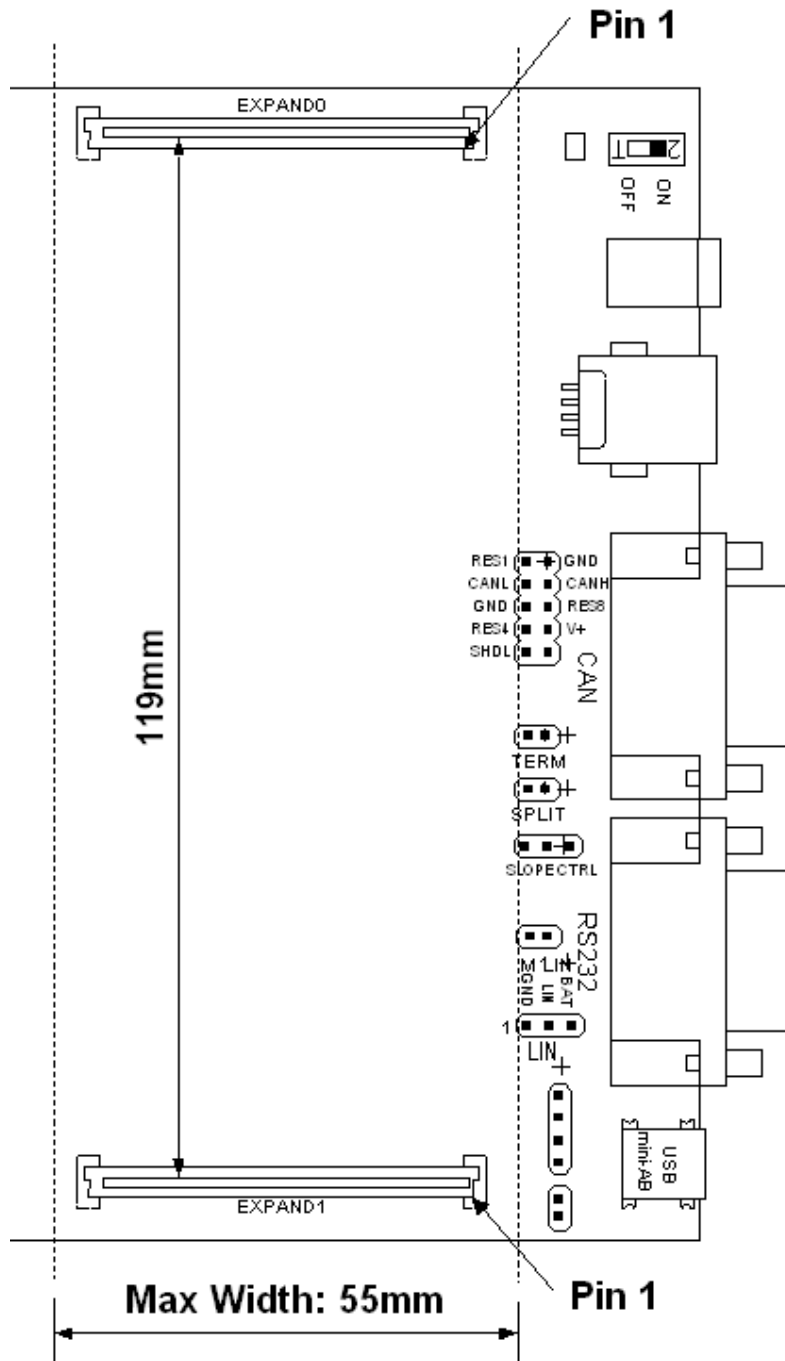
#### 3.1 Connector MPN

Table 3-1. Expansion card connector.

| Manufacturer and MPN | Quantity | Comment |
|----------------------|----------|---------|
| FCI, 61082-101402LF  | 2        |         |

### 3.2 Physical dimensions and component placement

Figure 3-1. Expansion card connector placement and dimensions.



There is no requirement to board thickness.

### 3.3 Atmel STK600 expansion connectors pinout

Figure 3-2. Pinout for expansion connectors.

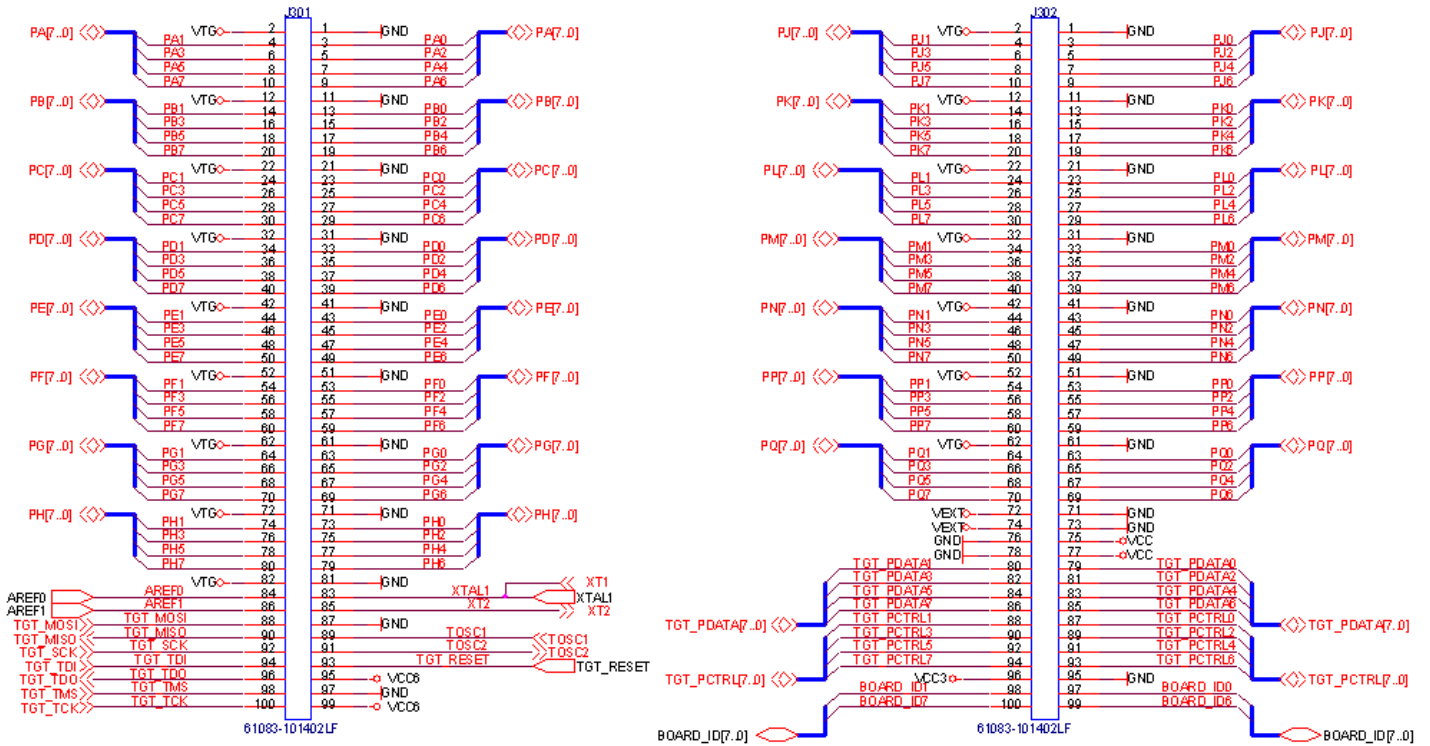


Table 3-2. STK600 J301 “expand0” connector pinout.

| Signal name | Pin number |    | Signal name |
|-------------|------------|----|-------------|
| VTG         | 2          | 1  | GND         |
| PA1         | 4          | 3  | PA0         |
| PA3         | 6          | 5  | PA2         |
| PA5         | 8          | 7  | PA4         |
| PA7         | 10         | 9  | PA6         |
| VTG         | 12         | 11 | GND         |
| PB1         | 14         | 13 | PB0         |
| PB3         | 16         | 15 | PB2         |
| PB5         | 18         | 17 | PB4         |
| PB7         | 20         | 19 | PB6         |
| VTG         | 22         | 21 | GND         |
| PC1         | 24         | 23 | PC0         |
| PC3         | 26         | 25 | PC2         |
| PC5         | 28         | 27 | PC4         |
| PC7         | 30         | 29 | PC6         |
| VTG         | 32         | 31 | GND         |
| PD1         | 34         | 33 | PD0         |

|          |     |    |           |
|----------|-----|----|-----------|
| PD3      | 36  | 35 | PD2       |
| PD5      | 38  | 37 | PD4       |
| PD7      | 40  | 39 | PD6       |
| VTG      | 42  | 41 | GND       |
| PE1      | 44  | 43 | PE0       |
| PE3      | 46  | 45 | PE2       |
| PE5      | 48  | 47 | PE4       |
| PE7      | 50  | 49 | PE6       |
| VTG      | 52  | 51 | GND       |
| PF1      | 54  | 53 | PF0       |
| PF3      | 56  | 55 | PF2       |
| PF5      | 58  | 57 | PF4       |
| PF7      | 60  | 59 | PF6       |
| VTG      | 62  | 61 | GND       |
| PG1      | 64  | 63 | PG0       |
| PG3      | 66  | 65 | PG2       |
| PG5      | 68  | 67 | PG4       |
| PG7      | 70  | 69 | PG6       |
| VTG      | 72  | 71 | GND       |
| PH1      | 74  | 73 | PH0       |
| PH3      | 76  | 75 | PH2       |
| PH5      | 78  | 77 | PH4       |
| PH7      | 80  | 79 | PH6       |
| VTG      | 82  | 81 | GND       |
| AREF0    | 84  | 83 | XTAL1     |
| AREF1    | 86  | 85 | XTAL2     |
| TGT_MOSI | 88  | 87 | GND       |
| TGT_MISO | 90  | 89 | TOSC1     |
| TGT_SCK  | 92  | 91 | TOSC2     |
| TDI      | 94  | 93 | TGT_RESET |
| TDO      | 96  | 95 | Vcc6      |
| TMS      | 98  | 97 | GND       |
| TCK      | 100 | 99 | Vcc6      |

**Table 3-3. Atmel STK600 J302 “expand1” connector pinout.**

| Signal name | Pin number |   | Signal name |
|-------------|------------|---|-------------|
| VTG         | 2          | 1 | GND         |
| PJ1         | 4          | 3 | PJ0         |
| PJ3         | 6          | 5 | PJ2         |
| PJ5         | 8          | 7 | PJ4         |
| PJ7         | 10         | 9 | PJ6         |

|            |    |    |            |
|------------|----|----|------------|
| VTG        | 12 | 11 | GND        |
| PK1        | 14 | 13 | PK0        |
| PK3        | 16 | 15 | PK2        |
| PK5        | 18 | 17 | PK4        |
| PK7        | 20 | 19 | PK6        |
| VTG        | 22 | 21 | GND        |
| PL1        | 24 | 23 | PL0        |
| PL3        | 26 | 25 | PL2        |
| PL5        | 28 | 27 | PL4        |
| PL7        | 30 | 29 | PL6        |
| VTG        | 32 | 31 | GND        |
| PM1        | 34 | 33 | PM0        |
| PM3        | 36 | 35 | PM2        |
| PM5        | 38 | 37 | PM4        |
| PM7        | 40 | 39 | PM6        |
| VTG        | 42 | 41 | GND        |
| PN1        | 44 | 43 | PN0        |
| PN3        | 46 | 45 | PN2        |
| PN5        | 48 | 47 | PN4        |
| PN7        | 50 | 49 | PN6        |
| VTG        | 52 | 51 | GND        |
| PP1        | 54 | 53 | PP0        |
| PP3        | 56 | 55 | PP2        |
| PP5        | 58 | 57 | PP4        |
| PP7        | 60 | 59 | PP6        |
| VTG        | 62 | 61 | GND        |
| PQ1        | 64 | 63 | PQ0        |
| PQ3        | 66 | 65 | PQ2        |
| PQ5        | 68 | 67 | PQ4        |
| PQ7        | 70 | 69 | PQ6        |
| Vext       | 72 | 71 | GND        |
| Vext       | 74 | 73 | GND        |
| GND        | 76 | 75 | Vcc        |
| GND        | 78 | 77 | Vcc        |
| TGT_PDATA1 | 80 | 79 | TGT_PDATA0 |
| TGT_PDATA3 | 82 | 81 | TGT_PDATA2 |
| TGT_PDATA5 | 84 | 83 | TGT_PDATA4 |
| TGT_PDATA7 | 86 | 85 | TGT_PDATA6 |
| TGT_PCTRL1 | 88 | 87 | TGT_PCTRL0 |
| TGT_PCTRL3 | 90 | 89 | TGT_PCTRL2 |
| TGT_PCTRL5 | 92 | 91 | TGT_PCTRL4 |

|            |     |    |            |
|------------|-----|----|------------|
| TGT_PCTRL7 | 94  | 93 | TGT_PCTRL6 |
| Vcc3       | 96  | 95 | GND        |
| BOARD_ID1  | 98  | 97 | BOARD_ID0  |
| BOARD_ID7  | 100 | 99 | BOARD_ID6  |



## 4. ID System

The Atmel STK600 features an ID system to identify which routing, socket and expansion card is attached. The STK600 can impose voltage limitations based on the IDs, and Atmel AVR Studio will notify the user if the combination is incorrect.

The ID system consists of two common output and two board unique input signals. Each input is one of sixteen possible values based in the input signals – giving a total ID space of 256.

Three IDs are reserved for custom use and can be implemented without use of ICs.

**Table 4-1. IDs reserved for custom use.**

| Type                  | ID   |
|-----------------------|------|
| Board limited to 1.8V | 0xCA |
| Board limited to 3.3V | 0xCC |
| No limit on voltage   | 0xCF |

The ID 0xff indicates no board present.

### 4.1 Signal usage

**Table 4-2. ID system signal usage.**

| Name      | Direction  | Function                   |
|-----------|------------|----------------------------|
| BOARD_ID0 | Output (A) | Common output to functions |
| BOARD_ID1 | Output (B) | Common output to functions |
| BOARD_ID2 | Input      | Input from routing card    |
| BOARD_ID3 | Input      | Input from routing card    |
| BOARD_ID4 | Input      | Input from socket card     |
| BOARD_ID5 | Input      | Input from socket card     |
| BOARD_ID6 | Input      | Input from expansion card  |
| BOARD_ID7 | Input      | Input from expansion card  |

## 4.2 ID functions

The functions and their output according to input A and B:

| B | A | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0  | 1  | 0  | 1  | 0  | 1  |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1  | 1  | 0  | 0  | 1  | 1  |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0  | 0  | 1  | 1  | 1  | 1  |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1  | 1  | 1  | 1  | 1  | 1  |

Functions as logic expressions:

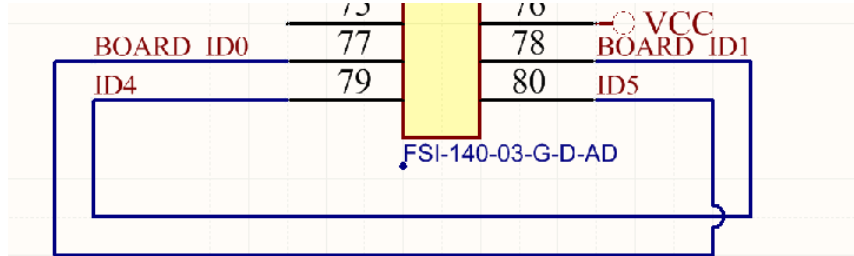
| Function | Expression                            | ID  |
|----------|---------------------------------------|-----|
| 0        | 0                                     | 0x0 |
| 1        | $\overline{A + B}$                    | 0x1 |
| 2        | $A\overline{B}$                       | 0x2 |
| 3        | $\overline{B}$                        | 0x3 |
| 4        | $\overline{A}B$                       | 0x4 |
| 5        | $\overline{A}$                        | 0x5 |
| 6        | $A \oplus B$                          | 0x6 |
| 7        | $\overline{A}B$                       | 0x7 |
| 8        | $AB$                                  | 0x8 |
| 9        | $\overline{A \oplus B}$               | 0x9 |
| 10       | $A$                                   | 0xA |
| 11       | $\overline{B} + AB$                   | 0xB |
| 12       | $B$                                   | 0xC |
| 13       | $B + \overline{A} \cdot \overline{B}$ | 0xD |
| 14       | $A + B$                               | 0xE |
| 15       | 1                                     | 0xF |

### 4.3 Examples

For a socket card to report the ID 0xCA:

Route BOARD\_ID1 to BOARD\_ID4 and BOARD\_ID0 to BOARD\_ID5

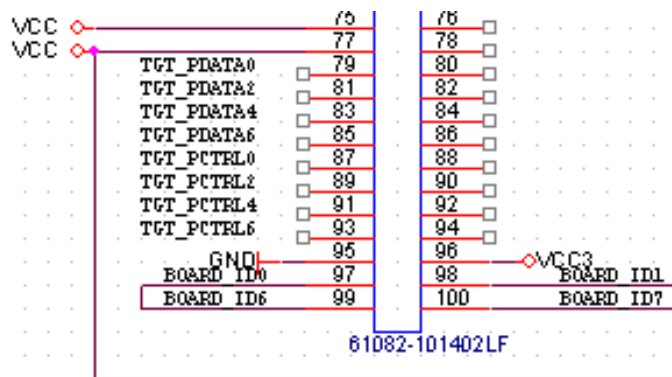
Figure 4-1. Socket card ID example.



For an expansion card to report the ID 0xCF:

Route BOARD\_ID0 to BOARD\_ID6 and VCC to BOARD\_ID7

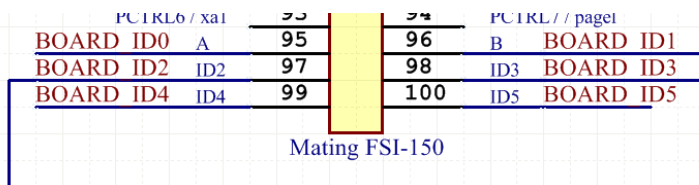
Figure 4-2. Expansion card ID example.



For a router card to report the ID 0xCC:

Route BOARD\_ID1 to both BOARD\_ID2 and BOARD\_ID3.

Figure 4-3. Routing card ID example.



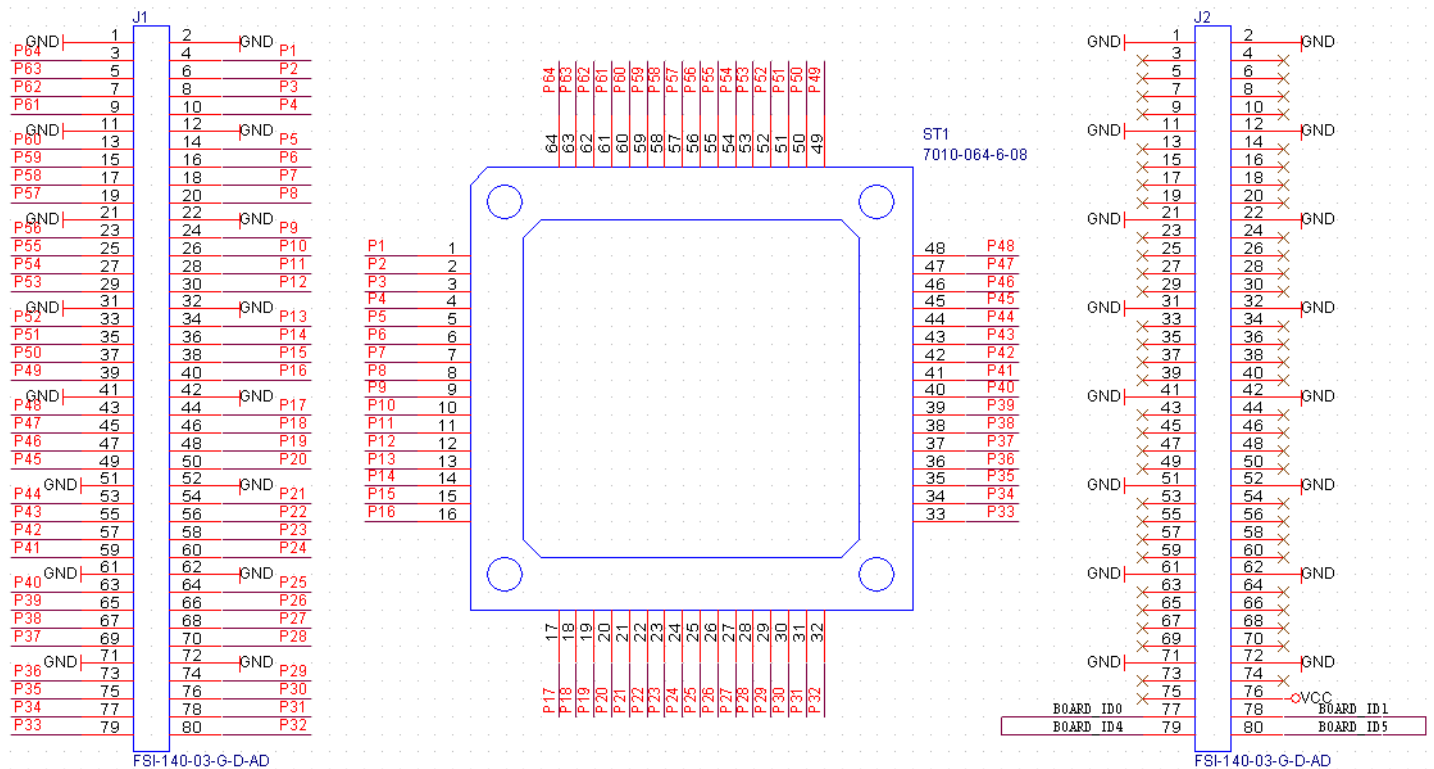
## 5. Design Example

To support a new package type one would typically start with designing the socket card. The pinout between the socket card and routing card is not defined and left to the designer. An example is given in Figure 5-1.

Next is the design of the routing card (Figure 5-3). The routing card's role is to connect each pin from the socket card to the corresponding pin on the Atmel STK600. In addition to decoupling etc, the routing card should also fan-out the correct signals to programming headers.

Each card in the stack has its own board\_id pins; the routing card is responsible for passing on the signal to the socket card.

Figure 5-1. Schema capture of socket card.



Both the socket and routing card must also include the clip holes:

Figure 5-2. Clip holes included in schematic.

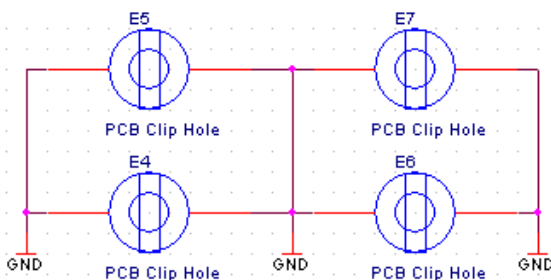
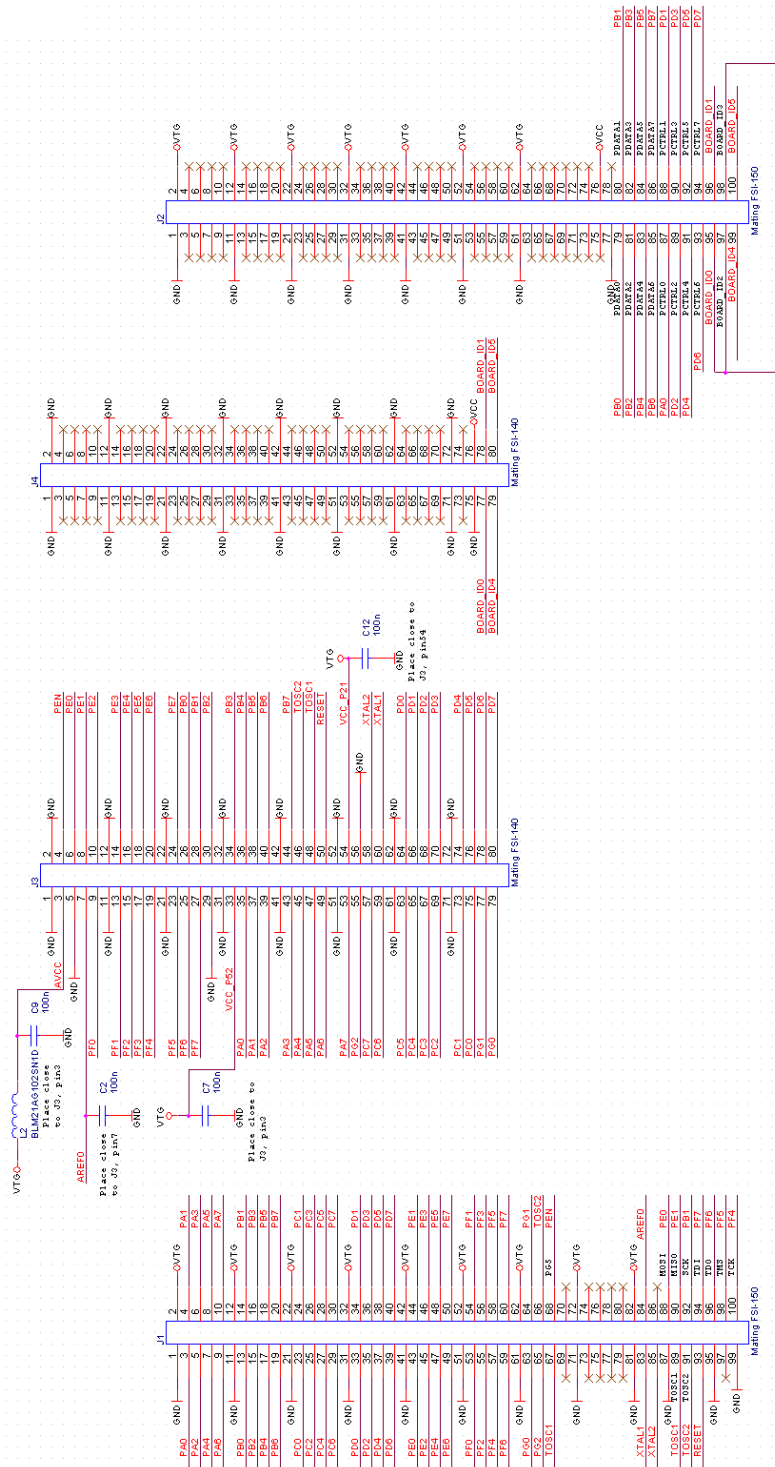


Figure 5-3. Schema capture of routing card.

STK600 Routing Card RC064M-9



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## 6. Revision History

| Doc. Rev. | Date    | Comments   |
|-----------|---------|--|
| 8170C     | 03/2013 | Example schematics for the ID system are updated |
| 8170B     | 12/2010 |  |
| 8170A     | 10/2008 | Initial document release                         |

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