Opamp Inverting Amplifier

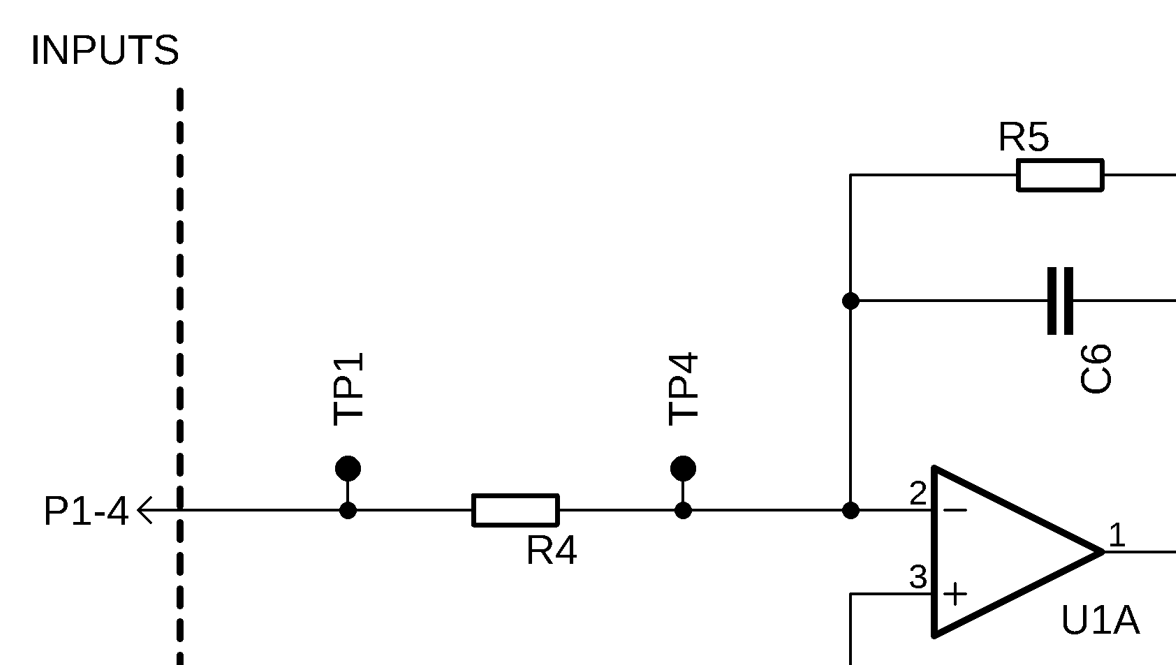
|  |  |
| --- | --- |
| **PART NUMBER** | 04A-005 |
| **GROUP NAME** | Opamp Amplifiers (04A) |
| **CIRCUIT NAME** | Inverting Amplifier |
| **VARIANT DESCRIPTION** | Single supply, DC Bias Trimmer |
| **BOARD DESIGN** | PCB50 |
| **PRODUCT DESCRIPTION** | Panel of 04A-005 miniPCBs, v-scored (1 Panel = 4 Pieces) |

# Basic Circuit Diagram

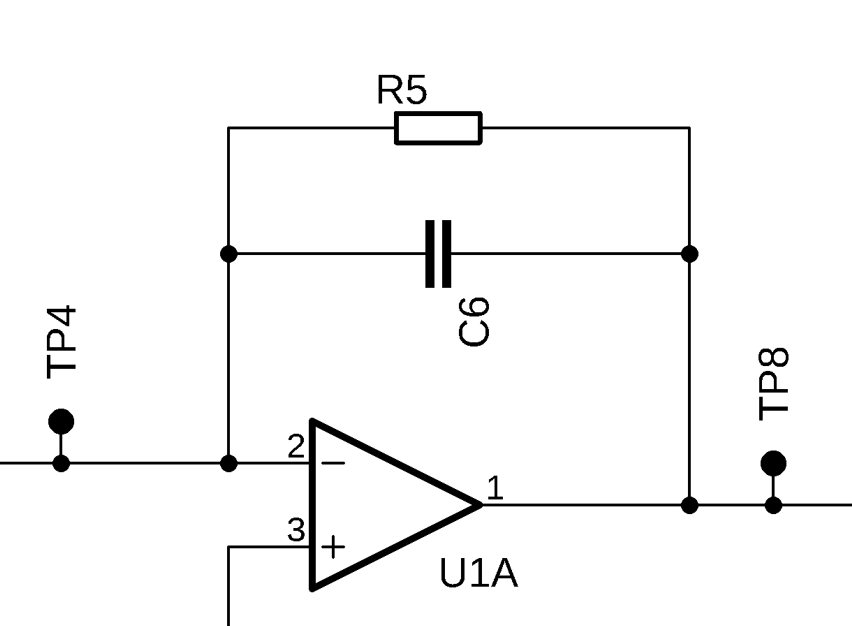
|  |
| --- |
| Inverting Operational Amplifier |
| Figure – Source: https://www.electronics-tutorials.ws/opamp/opamp\_2.html |

# Theory of Operation

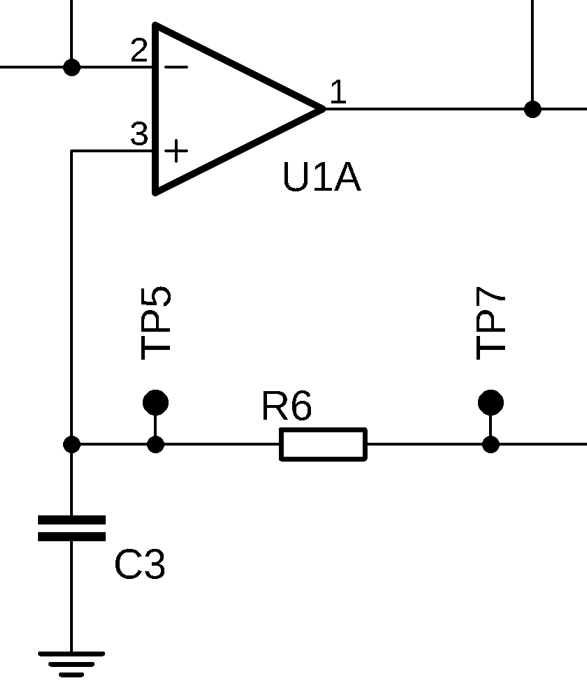
This circuit amplifies a voltage signal. Since there is no DC blocking capacitor on the signal input pin P1-4, the DC voltage difference between pin P1-4 and the reference voltage set by the trimmer potentiometer R2 will be amplified.



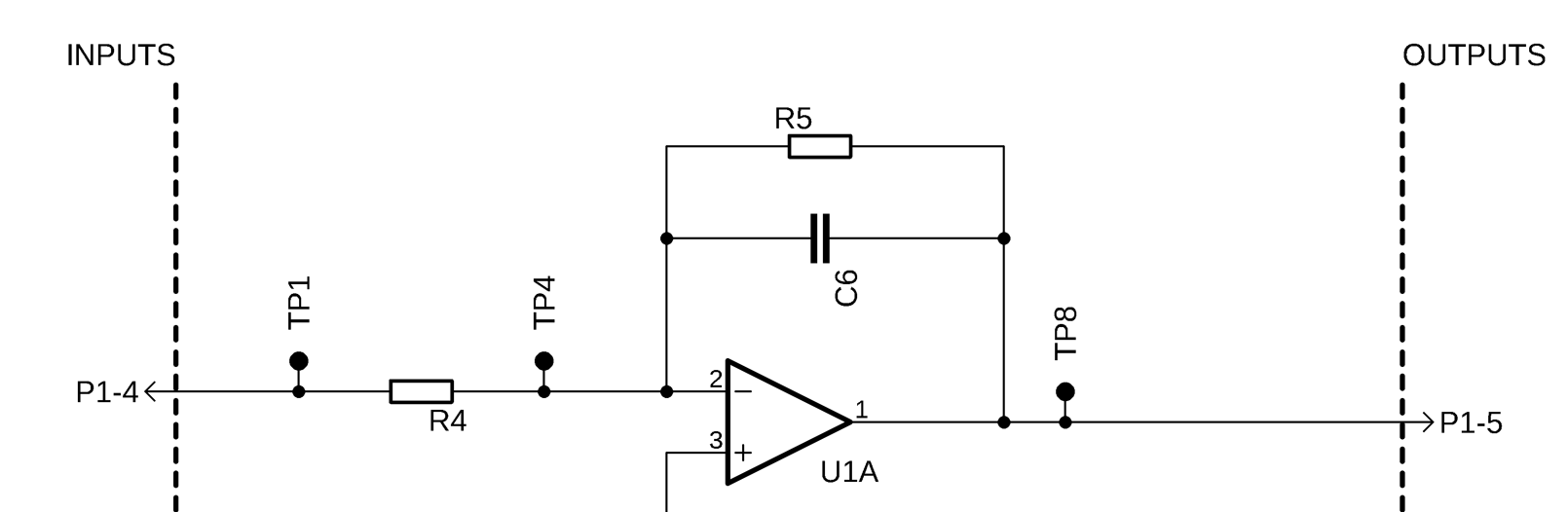
The feedback capacitor C6 allows larger feedback resistor values to be used without decreasing the amplifier’s gain bandwidth.



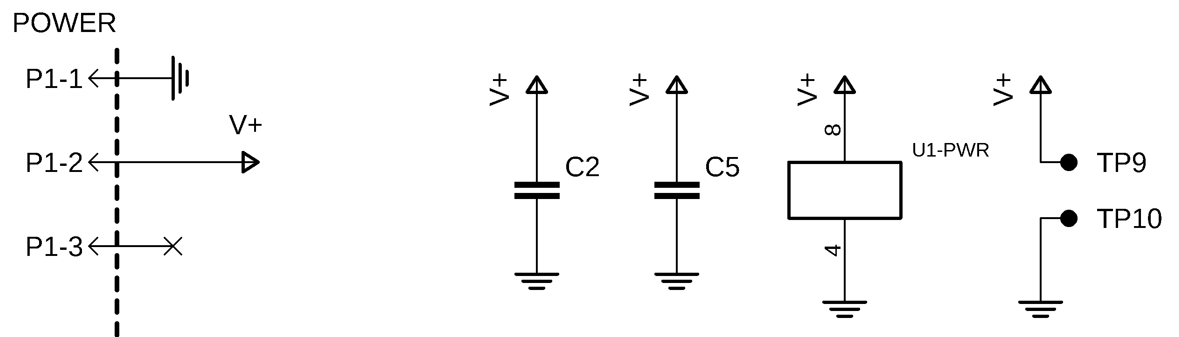
A low-pass Butterworth filter is formed by resistor R6 and capacitor C3 to minimize noise on the non-inverting opamp input.



The input impedance is largely determined by resistor R4. The output impedance is largely determined by opamp U1.



The minimum and maximum supply voltage is largely determined by opamp U1. Only the V+ power source is needed to operate this circuit.

Capacitors C2 and C5 filter the V+ power rail. Using capacitors with different values, generally between 10X and 1000X different, will provide better performance than two capacitors with similar values. Using low noise dielectric capacitors are recommended.

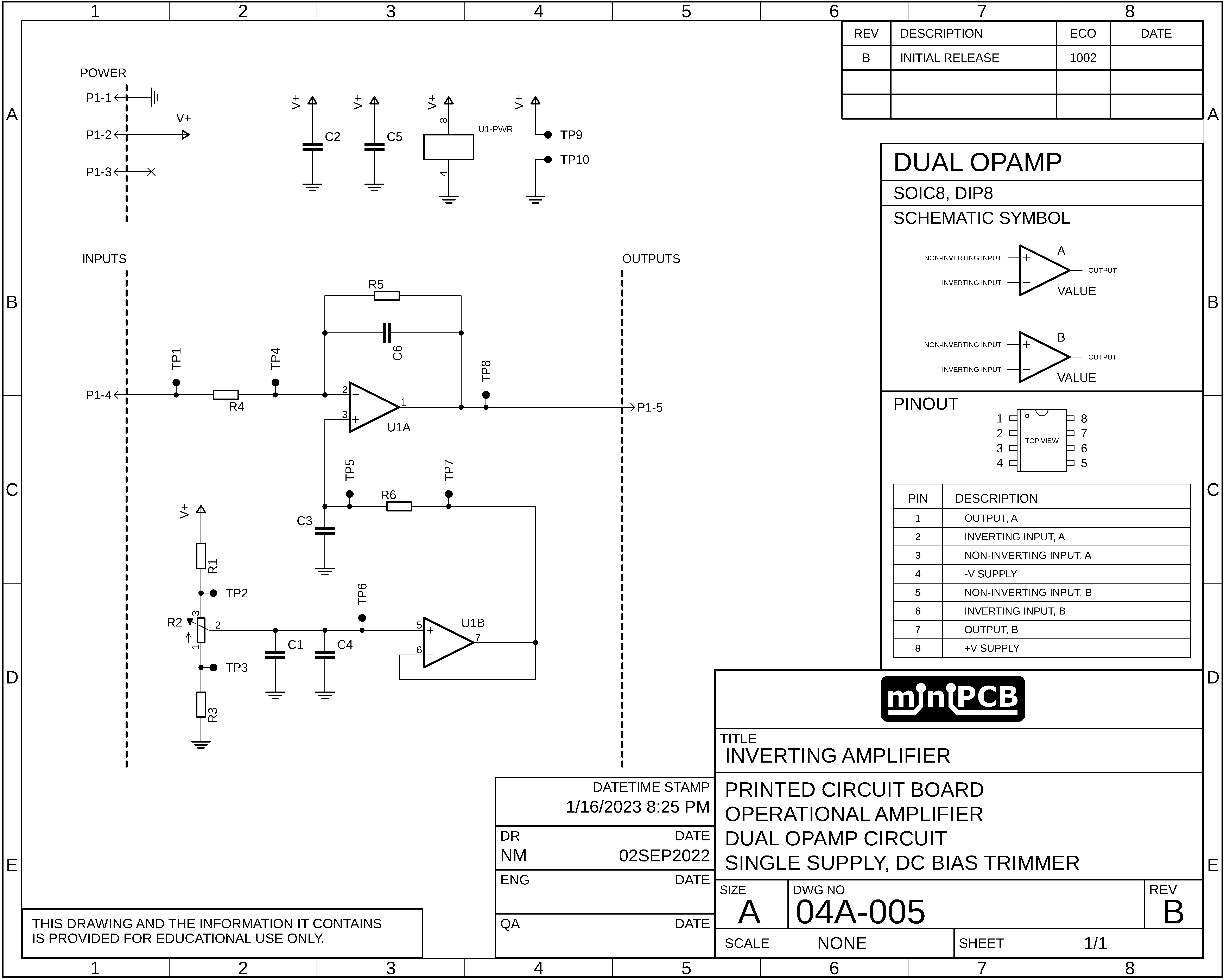
# Panel Board

|  |  |
| --- | --- |
|  |  |
| TOP VIEW | BOTTOM VIEW |

# Single Board

|  |  |
| --- | --- |
| Shape  Description automatically generated with low confidence | Shape  Description automatically generated with low confidence |
| TOP VIEW | BOTTOM VIEW |

|  |  |
| --- | --- |
|  |  |
| TOP VIEW | BOTTOM VIEW |



# Design Example

## Parts List

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **QTY REQ** | **PART** | **REF DES** | **MFG** | **MFG PN** | **VALUE** | **FIND** |
| 1 | PCB | - | miniPCB | 04A-005 | N/A | 1 |
| 1 | CAPACITOR | C1 | NICHICON | UFW2A470MPD | 47 uF | 2 |
| 1 | CAPACITOR | C2 | TDK | FA28X7S2A473KRU06 | 47 nF | 3 |
| 1 | CAPACITOR | C3 | TDK | FA28X7S2A473KRU06 | 47 nF | 4 |
| 1 | CAPACITOR | C4 | TDK | FA28X7S2A473KRU06 | 47 nF | 5 |
| 1 | CAPACITOR | C5 | NICHICON | UFW2A470MPD | 47 uF | 6 |
| 1 | CAPACITOR | C6 | TDK | FA24NP02W102JNU06 | 1000pF | 7 |
| 1 | PINS, 2mm | P1 | MOLEX | 87754-0552 | N/A | 8 |
| 1 | RESISTOR | R1 | VISHAY | RL07S101GRE6 | 100 Ω | 9 |
| 1 | TRIMMER | R2 | VISHAY | T93YA104KT20 | 100 KΩ | 10 |
| 1 | RESISTOR | R3 | VISHAY | RL07S101GRE6 | 100 Ω | 11 |
| 1 | RESISTOR | R4 | VISHAY | PTF6550R000BYEK | 50 Ω | 12 |
| 1 | RESISTOR | R5 | VISHAY | PTF56500R00BYEB | 500 Ω | 13 |
| 1 | RESISTOR | R6 | VISHAY | RL07S101GRE6 | 100 Ω | 14 |
| 1 | OPAMP, DUAL | U1 | NISSHINBO | NJM2904D | N/A | 15 |
| NISSHINBO | NJM14558D |
| TAIWAN SEMICONDUCTOR | TS358 |
| MICROCHIP | MCP6002-I/P |
| ANALOG DEVICES | AD827JNZ |
| TEXAS INSTRUMENTS | LF412CP |
| 10 | TEST POINT | TP\* | KEYSTONE ELECTRONICS | 5000 | N/A | 16 |

## Assembly

I want this section to include step by step pictures of the assembly process.

Capture the imaginations of the readers.

Make it look like I’m having fun.

## Testing

### Test List

| **TEST #** | **TEST NAME** | **TEST DESCRIPTION** |
| --- | --- | --- |
| 1 | +V Bus Short-Circuit | Measure resistance between TP9 and TP10. |
| 2 | U1 Pin 2 Short-Circuit | Measure resistance between TP1 and TP10. |
| 3 | U1 Pin 1 Short-Circuit | Measure resistance between TP8 and TP10. |
| 4 | Resistance Value, R1 | Measure resistance between TP9 and TP2. |
| 5 | Resistance Value, R2 | Measure resistance between TP2 and TP3. |
| 6 | Resistance Value, R3 | Measure resistance between TP3 and TP10. |
| 7 | Resistance Value, R4 | Measure resistance between TP1 and TP4. |
| 8 | Resistance Value, R5 | Measure resistance between TP4 and TP8. |
| 9 | Resistance Value, R6 | Measure resistance between TP5 and TP7. |
| 10 | Capacitance Value, C3 | Measure capacitance between TP5 and TP10. |
| 11 | Capacitance Value, C4 | Measure capacitance between TP6 and TP10. |
| 12 | Capacitance Value, C5 | Measure capacitance between TP9 and TP10. |
| 13 | Capacitance Value, C6 | Measure capacitance between TP4 and TP8. |
| 14 | Safe Turn-On | Apply power while monitoring current draw. |
| 15 | Voltage Adjustment, TP5 | Set voltage between TP5 and TP10 to 2.50 V. |
| 16 | Standby Power Consumption | Measure power consumption during standby operation. |
| 17 | Common-Mode Offset | TBD (Waveforms) |
| 18 | Output Voltage Swing | TBD (Waveforms) |
| 19 | Output Impedance | TBD (Waveforms) |
| 20 | Impulse Response | TBD (Waveforms) |
| 21 | Step Response | TBD (Waveforms) |
| 22 | BODE Plot | TBD (Waveforms) |

### Test Results

### Test Conclusions

## Performance

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **POWER REQUIREMENTS** | | | | | | |
| **PARAMETER NAME** | **SYMBOL** | | **UNITS** | **LOWER LIMIT** | **TARGET VALUE** | **UPPER LIMIT** |
| Postive DC Supply | +V | | V | 3.1 | 3.3 | 3.5 |
| Negative DC Supply | -V | | V | N/A | N/A | N/A |
| **STIMULI REQUIREMENTS** | | | | | | |
| **PARAMETER NAME** | **SYMBOL** | | **UNITS** | **LOWER LIMIT** | **TARGET VALUE** | **UPPER LIMIT** |
| Maximum Voltage Gain |  | |  | 9.9 | 10.0 | 10.1 |
| Bandwidth |  | | Hz |  | 5 MHz |  |
| Common-Mode Offset |  | |  |  |  |  |
| Common-Mode Gain |  | |  |  |  |  |
| Maximum Input Bias Current |  | | A |  |  |  |
| Maximum Phase Shift |  | |  |  |  |  |
| Source Impedance |  | | Ω |  |  |  |
| **PERFORMANCE CHARACTERISTICS** | | | | | | |
| **PARAMETER NAME** | **SYMBOL** | **UNITS** | | **LOWER LIMIT** | **TARGET VALUE** | **UPPER LIMIT** |
| Quiescient Current |  | A | | 0.01 | 0.02 | 0.03 |
| Voltage Gain |  |  | |  | 10 |  |
| Input Impedance |  | Ω | |  | 50 |  |
| Output Impedance |  | Ω | |  | 0.001 |  |

# Engineering Forms

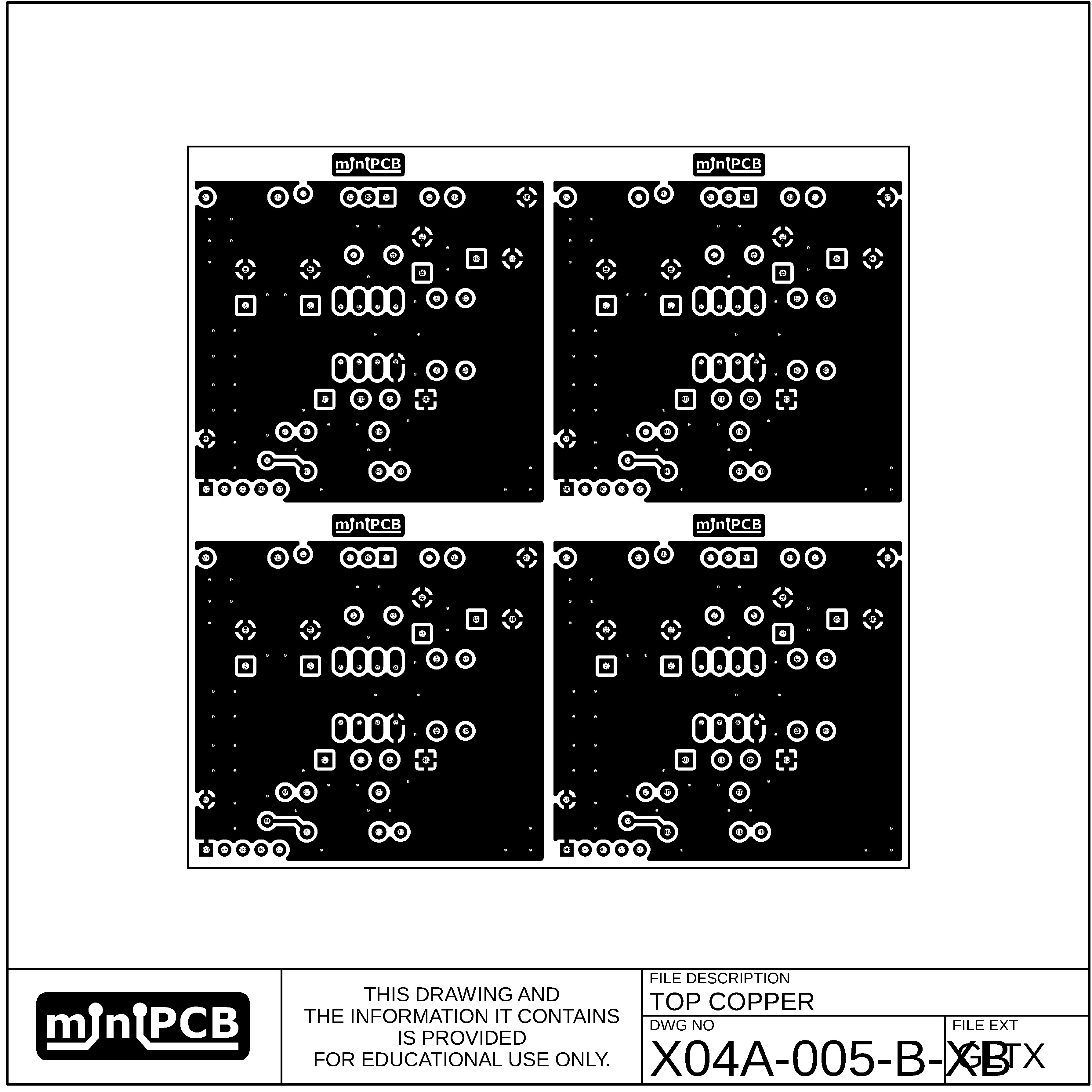
## Parts List (FORM)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **QTY REQ** | **PART** | **REF DES** | **MFG** | **MFG PN** | **VALUE** | **FIND** |
| 1 | PCB | - | miniPCB | 04A-005 | N/A | 1 |
| 1 | CAPACITOR | C1 |  |  |  | 2 |
| 1 | CAPACITOR | C2 |  |  |  | 3 |
| 1 | CAPACITOR | C3 |  |  |  | 4 |
| 1 | CAPACITOR | C4 |  |  |  | 5 |
| 1 | CAPACITOR | C5 |  |  |  | 6 |
| 1 | CAPACITOR | C6 |  |  |  | 7 |
| 1 | PINS, 2mm | P1 |  |  | N/A | 8 |
| 1 | RESISTOR | R1 |  |  |  | 9 |
| 1 | TRIMMER | R2 |  |  |  | 10 |
| 1 | RESISTOR | R3 |  |  |  | 11 |
| 1 | RESISTOR | R4 |  |  |  | 12 |
| 1 | RESISTOR | R5 |  |  |  | 13 |
| 1 | RESISTOR | R6 |  |  |  | 14 |
| 1 | OPAMP, DUAL | U1 |  |  | N/A | 15 |
| 10 | TEST POINT | TP\* | KEYSTONE ELECTRONICS | 5000 | N/A | 16 |

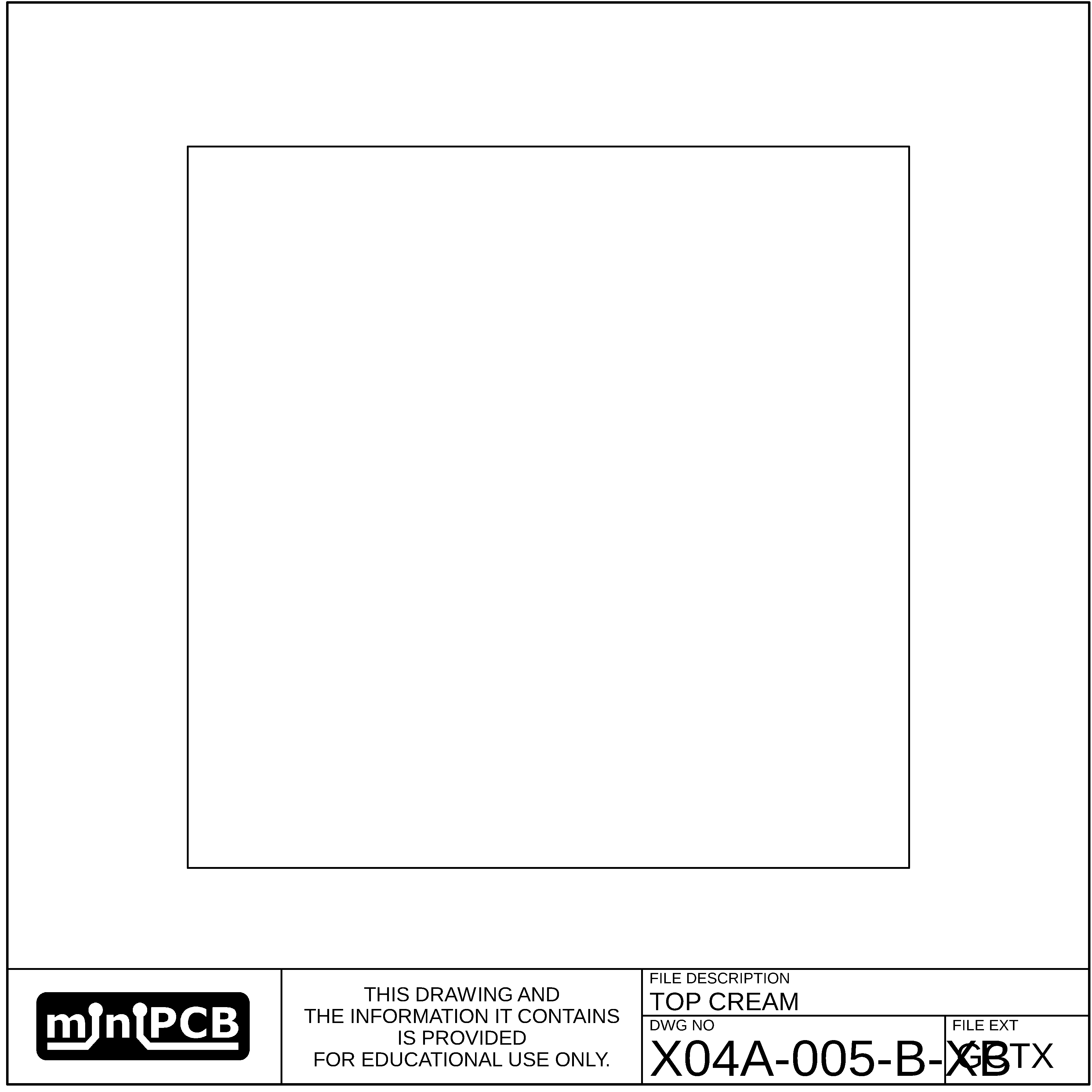
# Gerber Files

This section contains images of the layers included in each Gerber file.

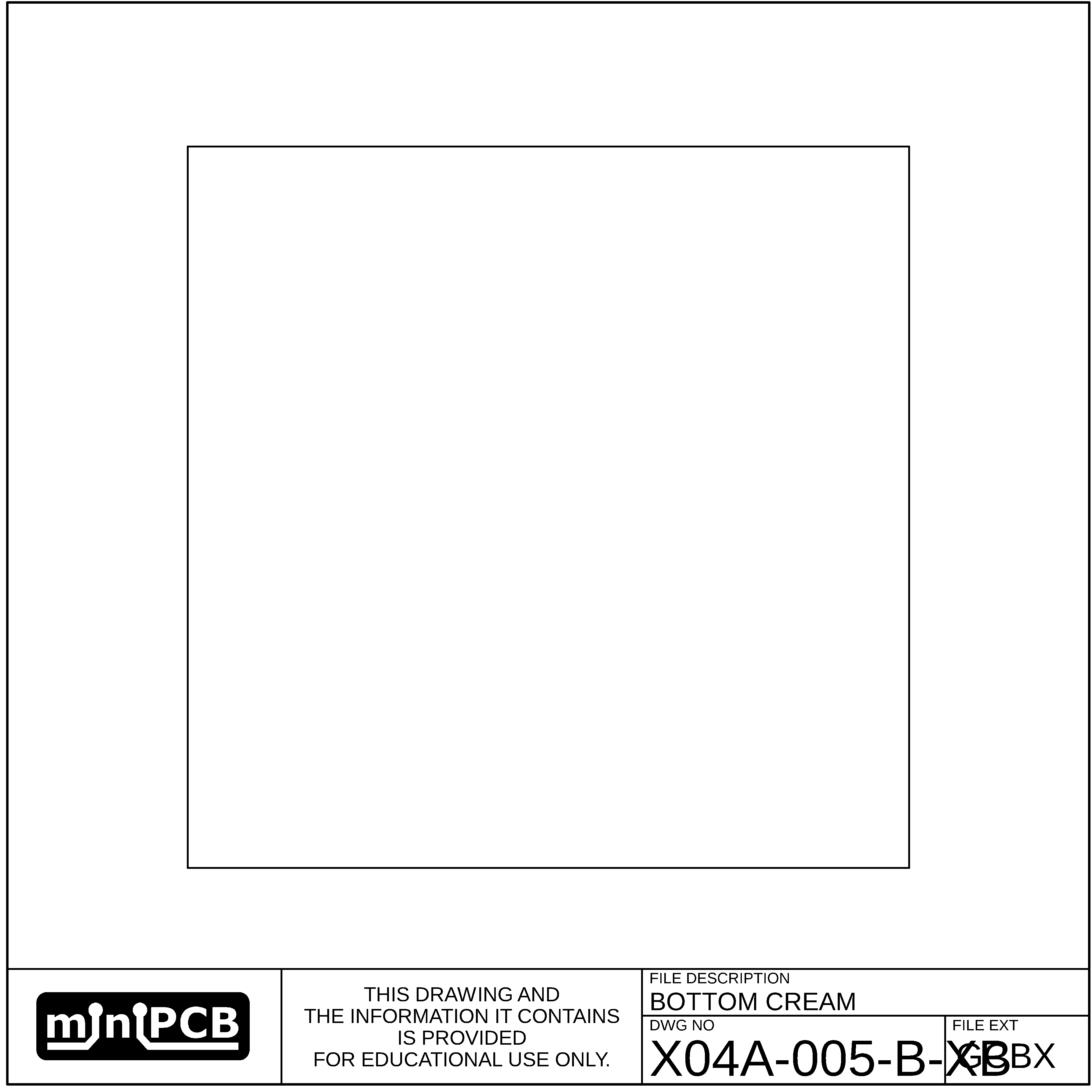
## TOP COPPER (GLTX)



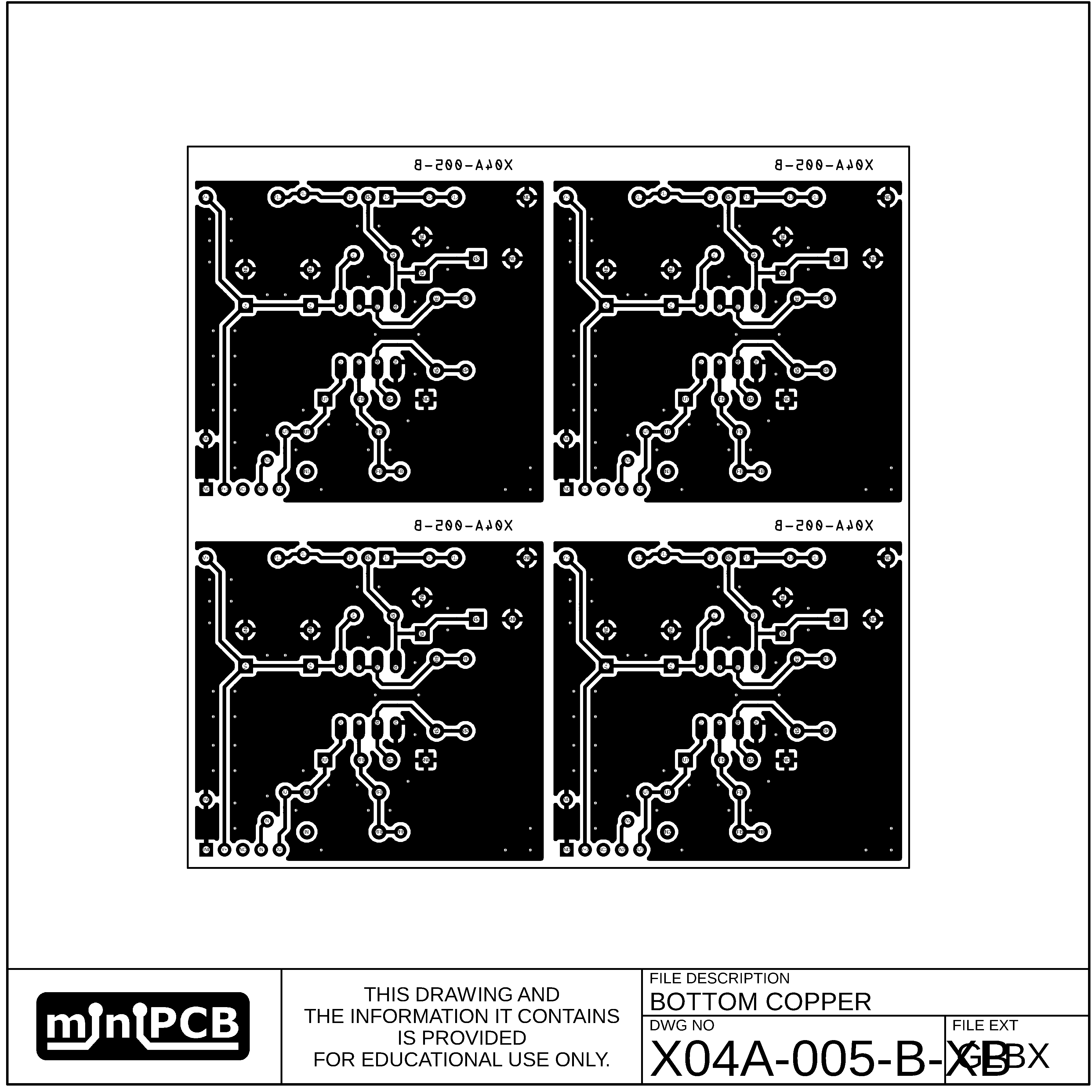
## TOP CREAM (GCTX)



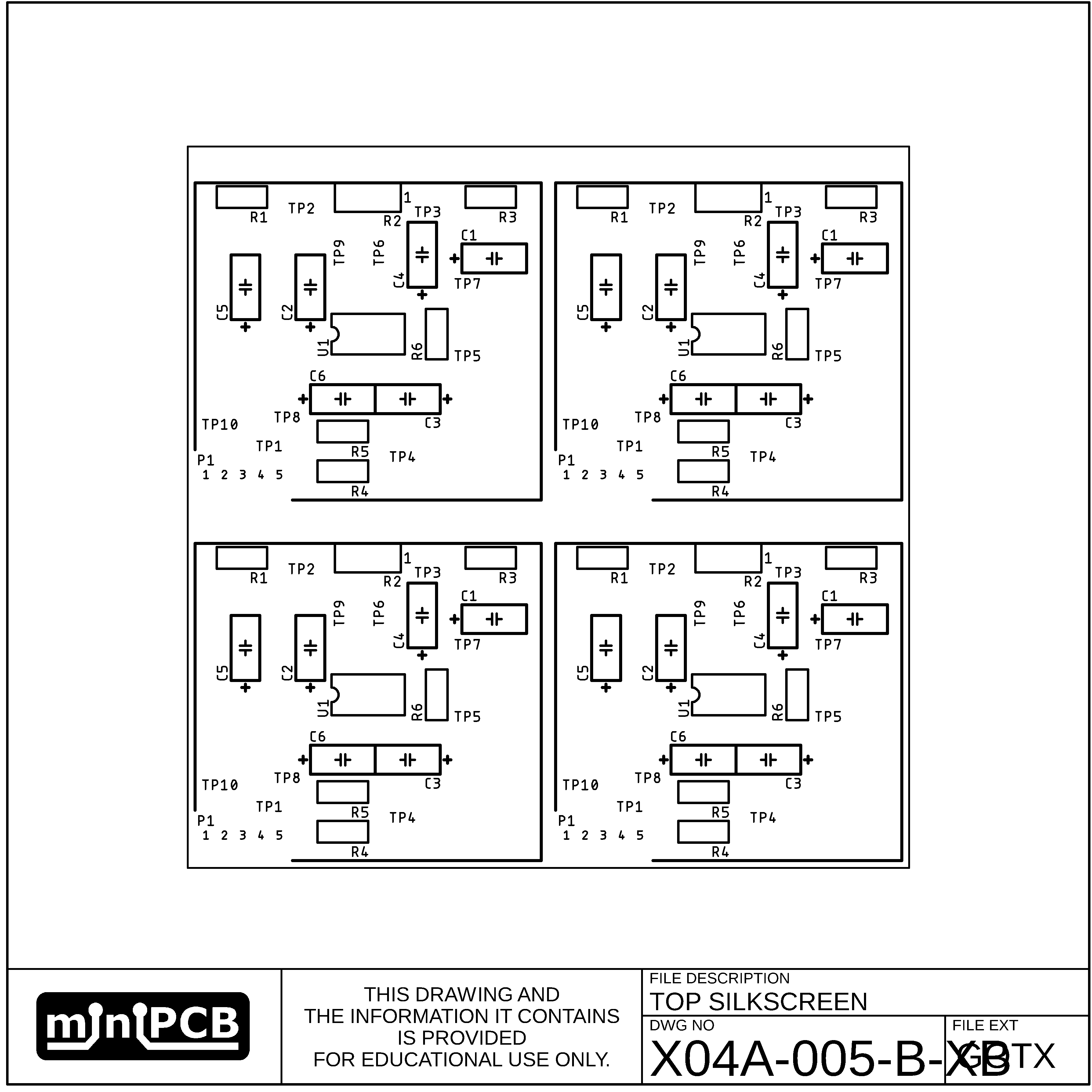
## BOTTOM CREAM (GCBX)



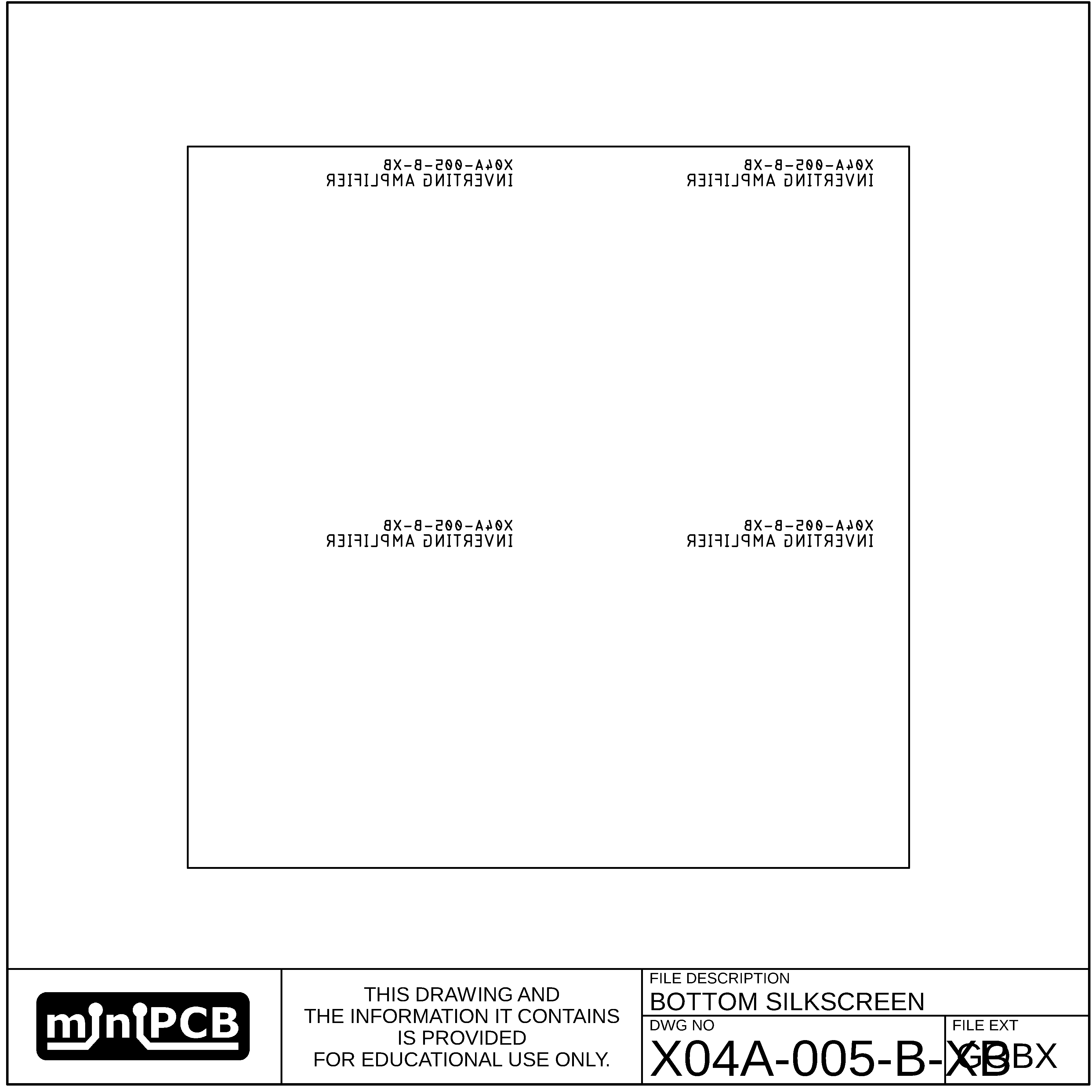
## BOTTOM COPPER (GLBX)



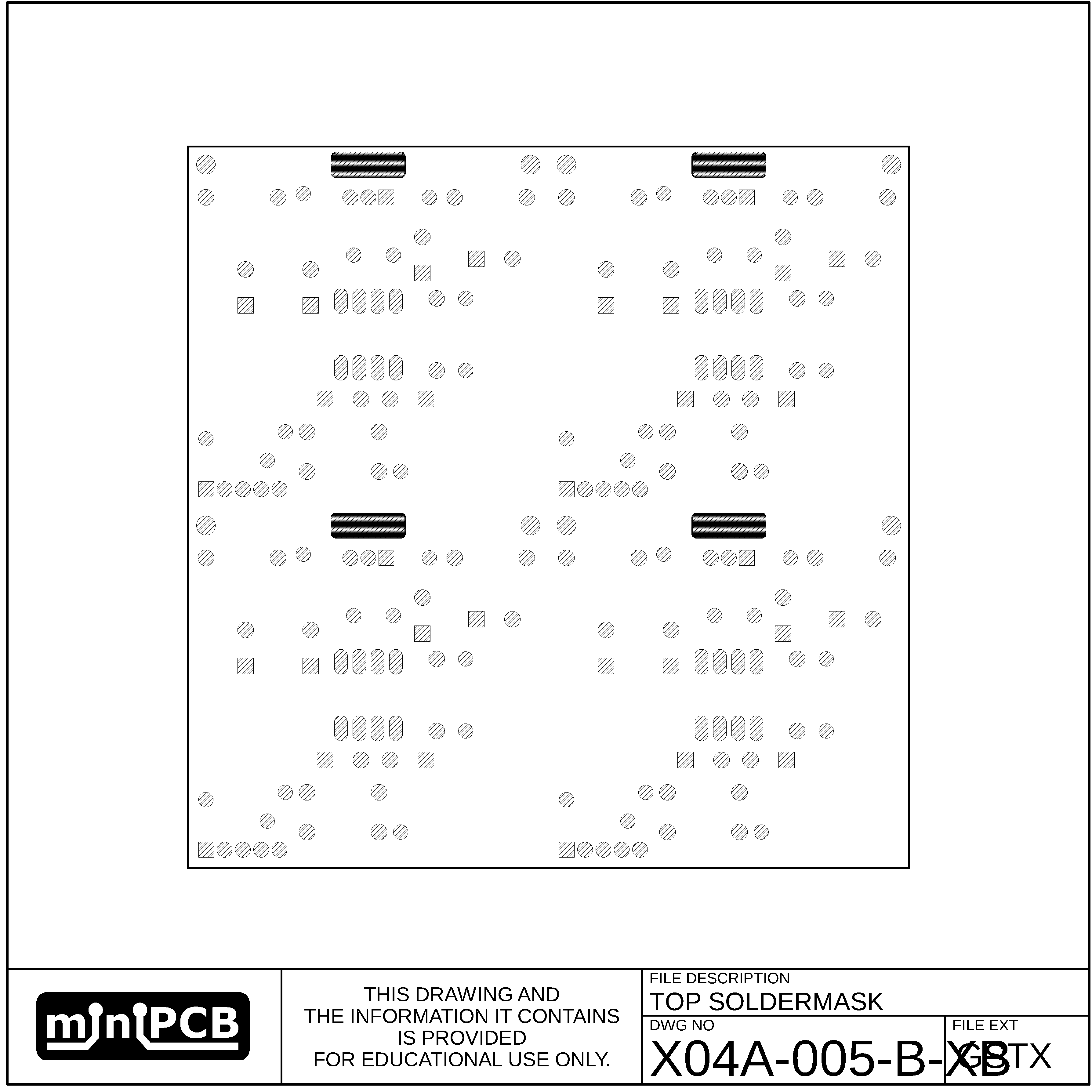
## TOP SILKSCREEN (GOTX)



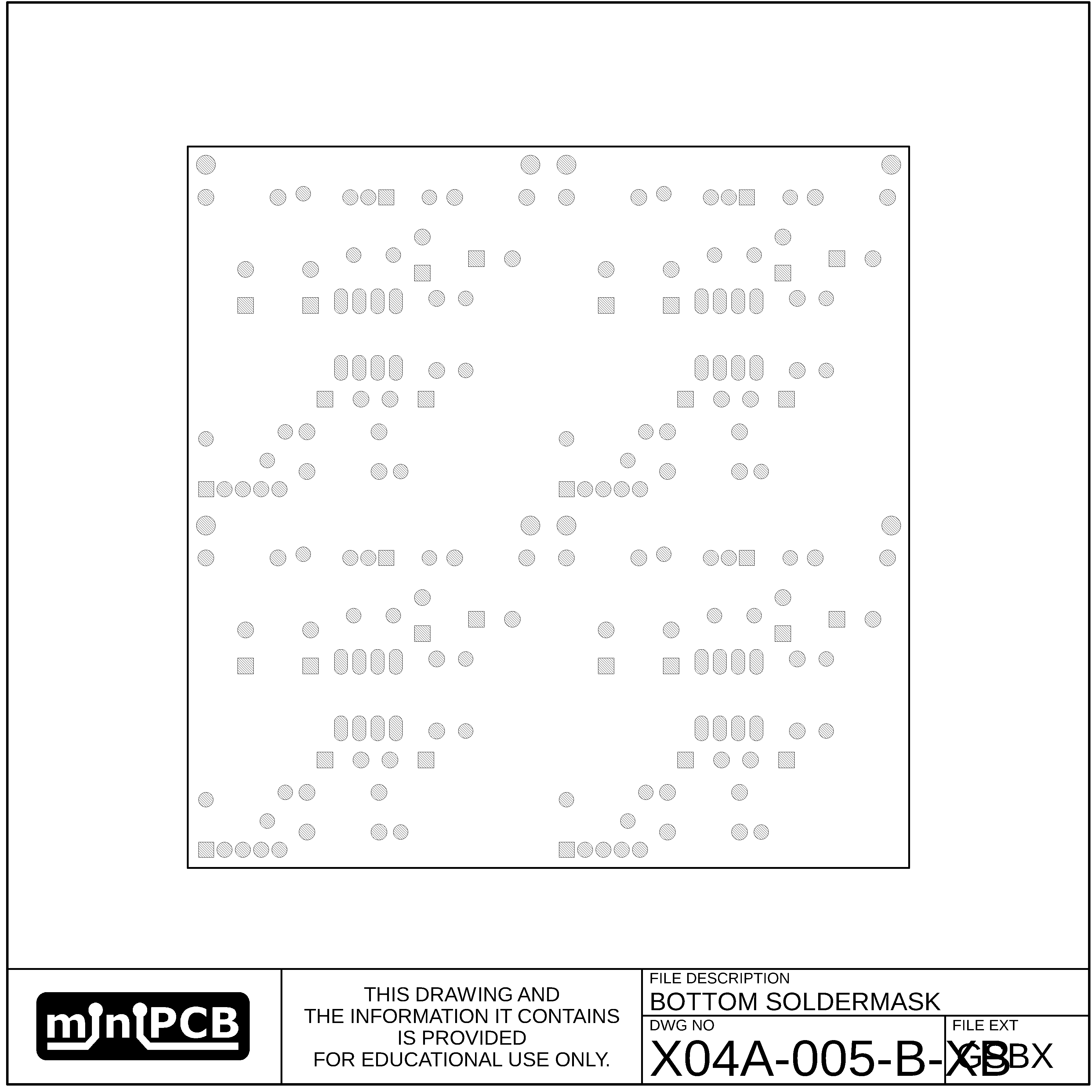
## BOTTOM SILKSCREEN (GOBX)



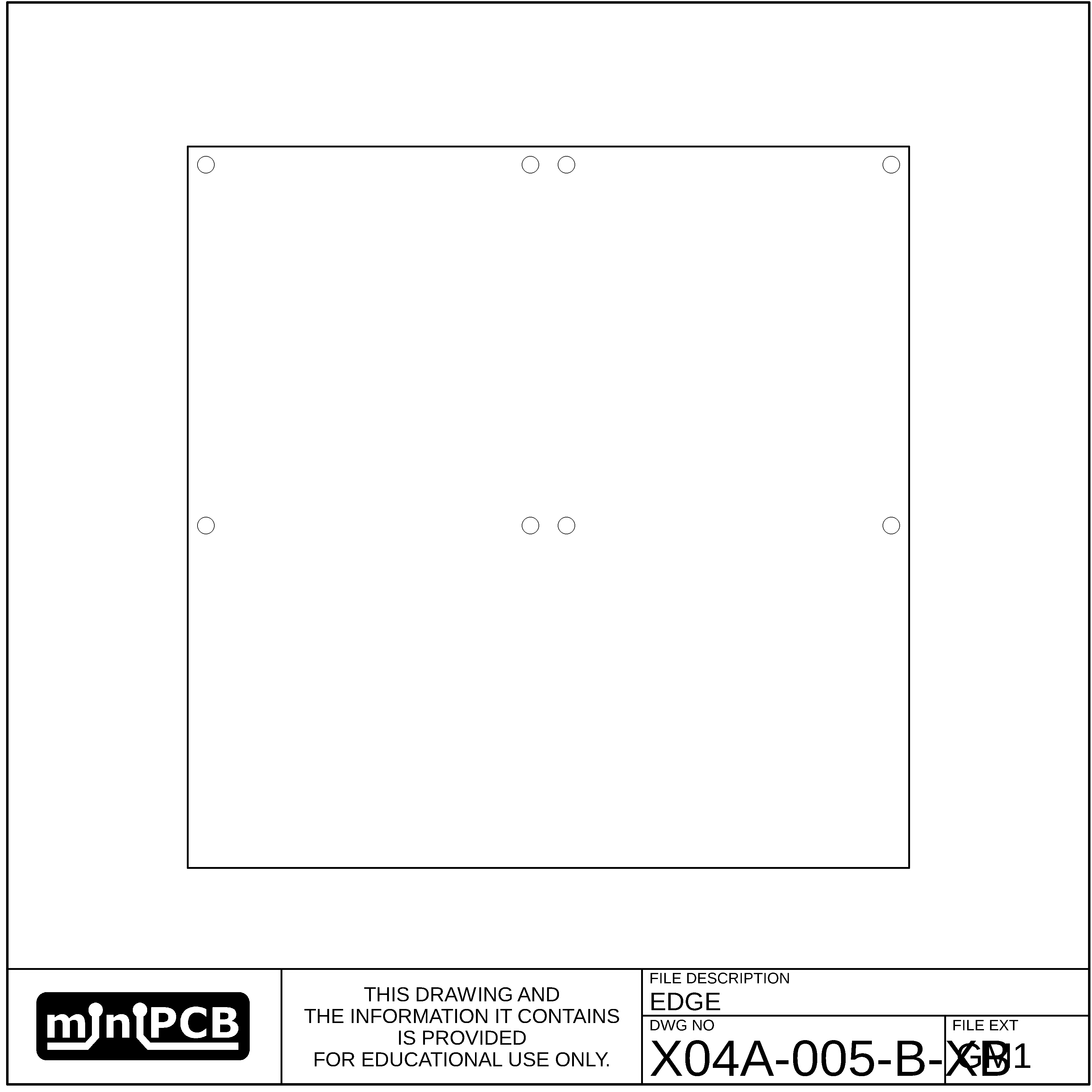
## TOP SOLDERMASK (GSTX)



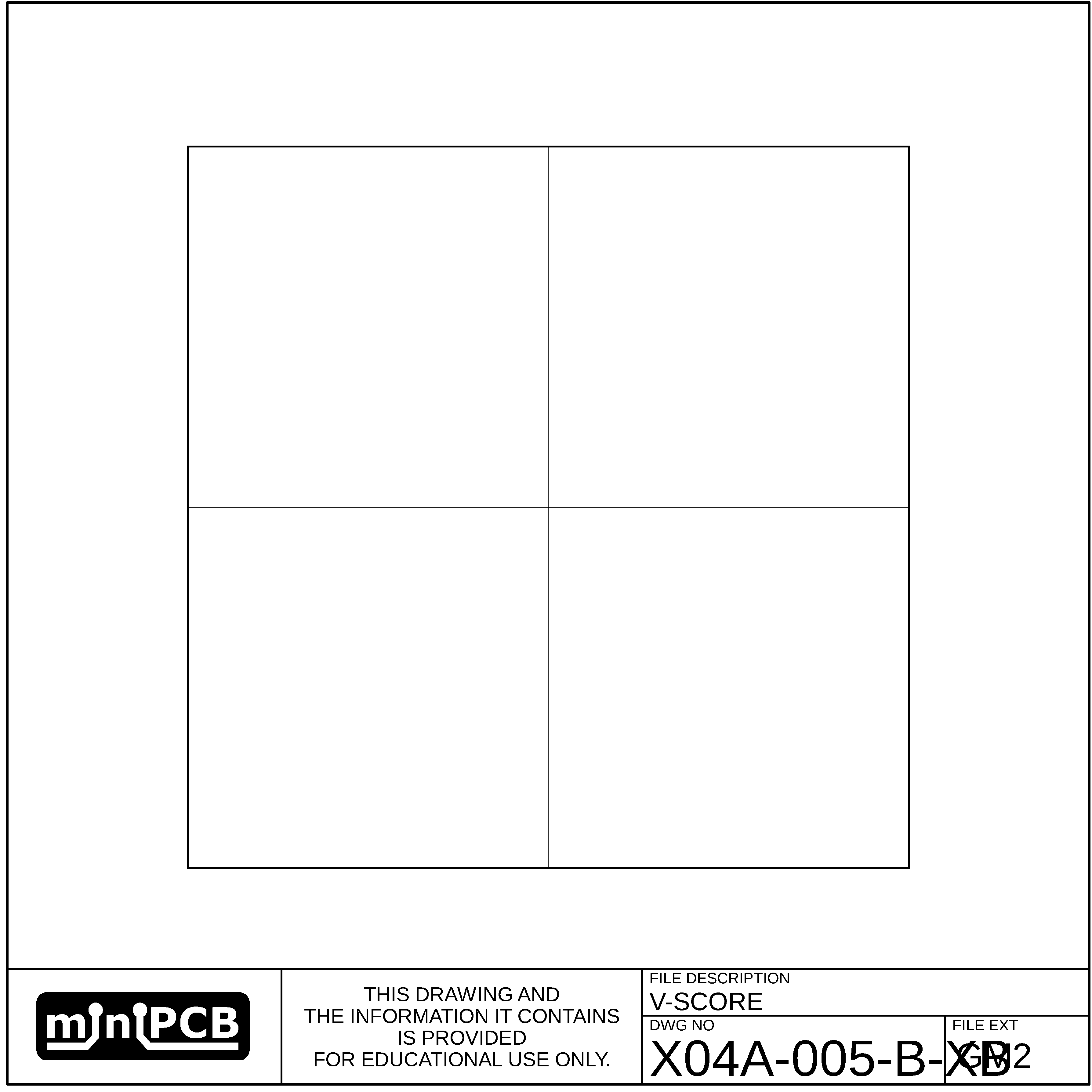
## BOTTOM SOLDER MASK (GSBX)



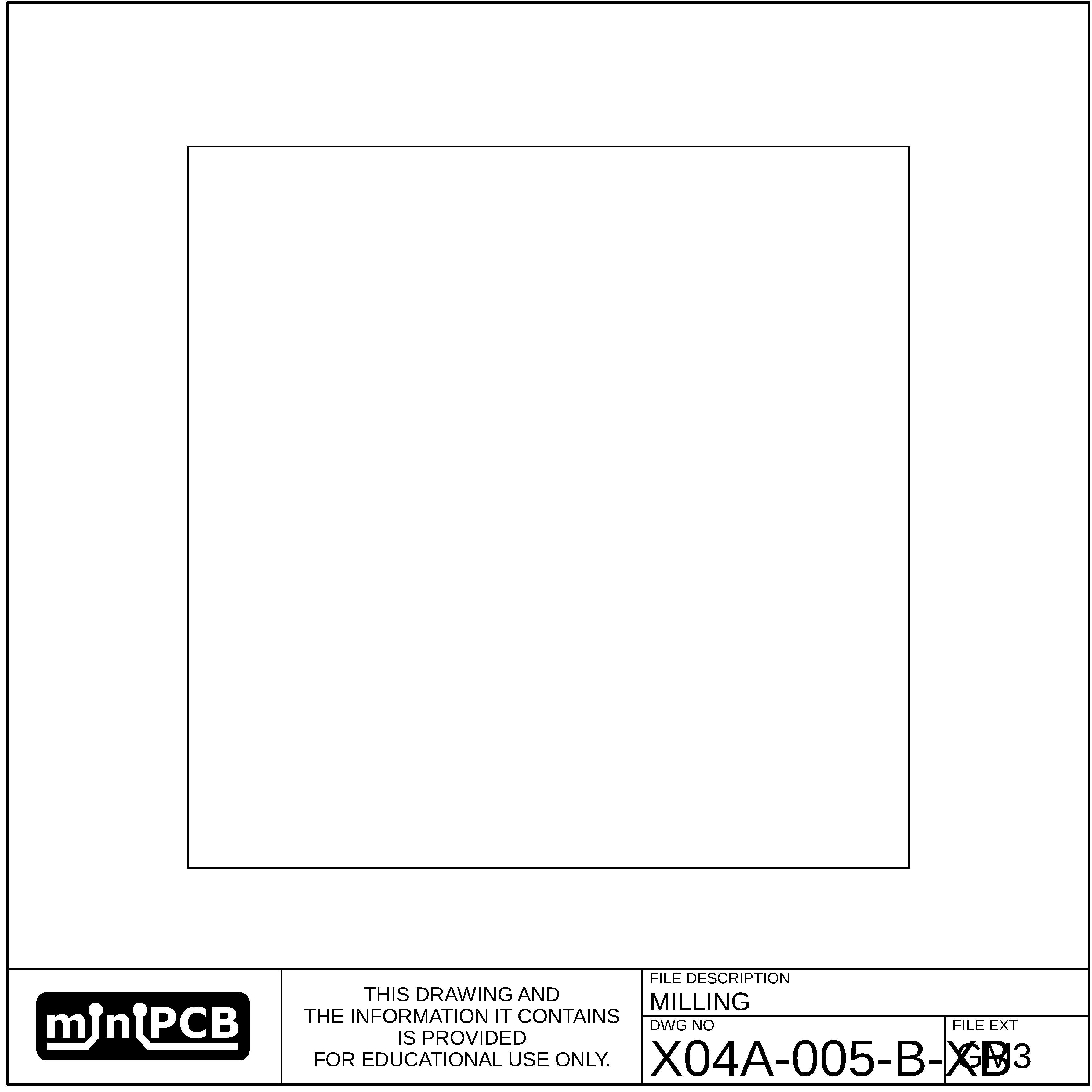
## EDGE (GM1)



## VSCORE (GM2)



## MILLING (GM3)



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|  |  |  |
| --- | --- | --- |
| WORDMARK | FIGUREMARK | FIGUREMARK |
| miniPCB™ | A picture containing drawing  Description automatically generated™ | Icon  Description automatically generated™ |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| REV | DESCRIPTION | ECO | DATE |
| A | Initial Release | 1002 |  |
|  |  |  |  |

# Related Content

|  |  |  |  |
| --- | --- | --- | --- |
| # | TYPE | DESCRIPTION | LOCATION |
| 1 | Sale Posting | eBay |  |
| 2 | Sale Posting | Mouser |  |
| 3 | Repository | Engineering Files | https://github.com/miniPCB/EAGLE/tree/main/miniPCB/04/A/04A-005 |
| 4 | Repository | Datasheet |  |
| 5 | Video | Development |  |
| 6 | Video | Development |  |
| 7 | Video | Testing |  |
| 8 | Video | Engineering Release |  |