To our customers,

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April 1st, 2010
Renesas Electronics Corporation

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User's Manual

# EB-78K0R-Kx3L

# Target Board for

## Low-Power µPD78F1009 and µPD78F1014 Microcontrollers

## EB-78K0R-KE3L
## EB-78K0R-KG3L

Document no. U19819EU1V0UM00

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M8E 02.10

## Revision History

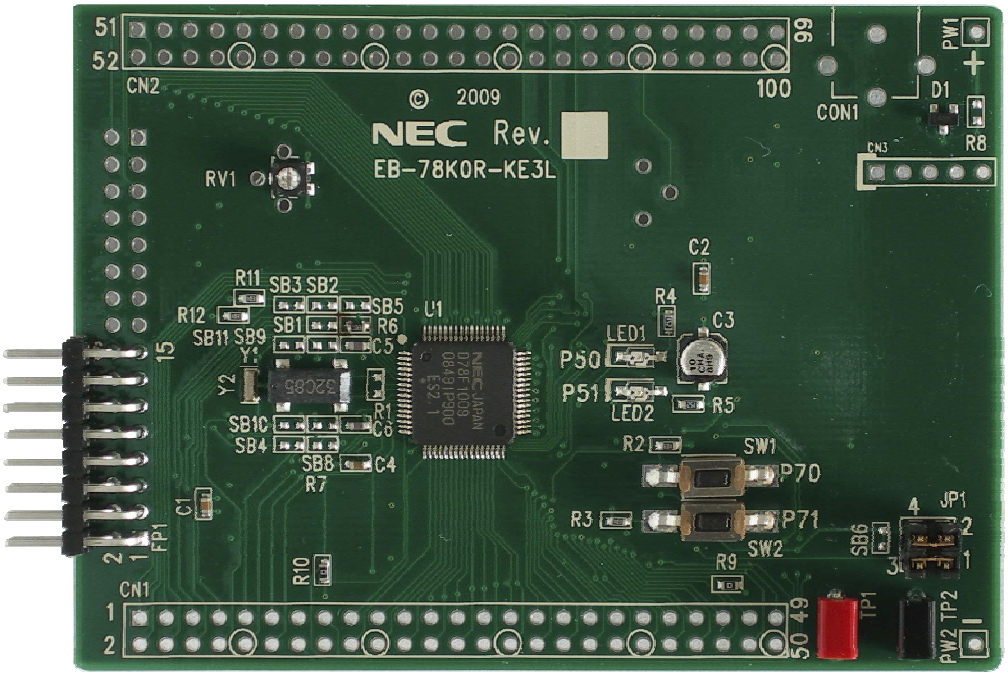
| Date | Revision | Section | Description |
|---|---|---|---|
| 5/14/09 | — | — | First release |
| | | | |
| | | | |
| | | | |

# Contents

## 1. Introduction

The EB-78K0R-Kx3L target board is designed to demonstrate low power usage functionality for the CPU and on-chip peripherals of the NEC Electronics 16-bit 78K0R/Kx3-L microcontrollers (MCUs), 64-pin (KE3-L) or 100-pin (KG3-L). The board can operate in standalone mode for evaluation of the MCU's main features or be connected to a USB based debug tool for on-chip debugging and flash memory programming (MINICUBE2™, QB-MINI2 or USB Debug Adapter, EB-USB-DA).

**Figure 1. EB-78K0R-Kx3L Target Board (Top View)**



# 2. System Specification

## 2.1 Microcontrollers

The features of the low power 78K0R/Kx3-L MCUs are similar.

- Up to 128 KB flash programming memory
- Up to 8KB high-speed data RAM
- Up to 89 I/O ports
- Two external oscillators
  - 2 to 20 MHz Main-clock
  - 32.768 Sub-clock
- Three internal oscillators
  - 20 MHz ± 1% high-speed oscillator
  - 1 MHz ± 5% high-speed oscillator
  - 30 KHz (TYP) low-speed oscillator
- Up to 16-channel, 10-bit A/D converter with Programmable gain amplifier
- Two comparators
- 2-channel DMA controller
- Two clock output/Buzzer output
- Communication
  - UART , CSI , $I^2C$ and LIN support
- Timers
  - Up to 12-channel, 16-bit timer array
  - One-channel, watchdog timer
  - One-channel, Real-Time-Counter (RTC)
- Interrupts
  - 33 internal interrupts and 13 external interrupts
  - 7 Key interrupt
- 16-bit Multiplier and 32-bit Divider
- Safety features
  - POC and 16-level Low Voltage Indicator (LVI)
- 1.8–5.5 $V_{DC}$ power supply voltage

#### 2.1.1 µPD78F1009GA MCU (Option 1) —78K0R/KE3-L

- Used for populating the EB-78K0R-KE3L target board
- 55 I/O ports
- 64-pin TQFP

#### 2.1.2 µPD78F1014GC MCU (Option 2) —78K0R/KG3-L

- Used for populating the EB-78K0R-KG3L target board
- 89 I/O ports
- 100-pin LQFP

### 2.2 Board

The target board is populated with either option 1 or option 2.

- Board dimensions - 2.5 × 3.5 inches (W × L)
- Coin cell battery holder for self-powered function with solar power connector for alternate power supply
- Connector for external target power supply
- Option 1
  - MCU I/O pins: CN1 and CN2 pin-out
  - 16-pin debug and flash programming interface connector: FP1
  - CPU current measurement terminals: TP1 and TP2
  - External power supply connector: CON1
  - Two LED indicators: LED1 and LED2
  - Two Tact Switches: SW1 and SW2
  - One trimmer port: RV1
- Option 2
  - MCU I/O pins: CN21 and CN22 pin-out
  - 16-pin debug and flash programming interface connector: FP21
  - CPU current measurement terminals: TP21 and TP22
  - External power supply connector: CON21
  - Two LED indicators: LED21 and LED22
  - Two Tact Switches: SW21 and SW22
  - One trimmer port: RV21

## 3. Hardware

**Figure 2. EB-78K0R-KE3L Target Board Layout**

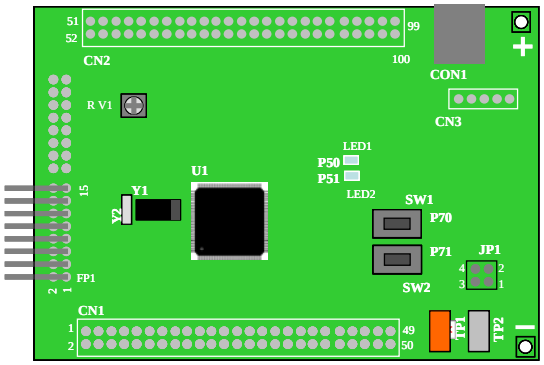



**Table 1. Default Jumper Settings**

| Jumper | Setting | Function | Default | Description |
|---|---|---|---|---|
| JP1 | 1–3 | VDD | CLOSED | Current measurement for core CPU |
| | 2–4 | EVDD+AVREF | CLOSED | Current measurement for peripherals |

**Figure 3. EB-78K0R-KG3L Target Board Layout**

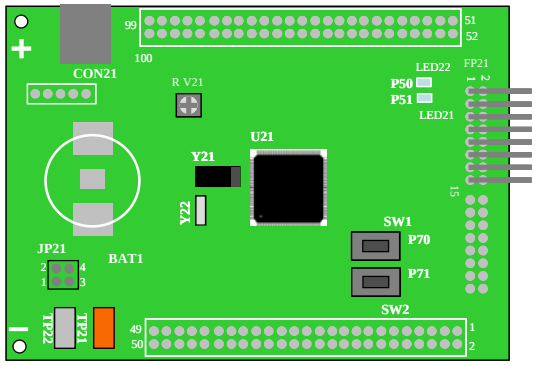



**Table 2. Default Jumper Settings**

| Jumper | Setting | Function | Default | Description |
|---|---|---|---|---|
| JP21 | 1–3 | VDD | CLOSED | Current measurement for core CPU |
| | 2–4 | EVDD+AVREF | CLOSED | Current measurement for peripherals |

## 3.1 Operating Modes

### 3.1.1 Demonstration Configuration

In standalone mode, the EB-78K0R-Kx3L target board can be used to execute programs loaded into the MCU's on-chip flash memory. This allows evaluation of CPU and on-chip peripheral functionality. By default, the board is configured for debugging code. To operate in standalone mode, disconnect the debug tool from connector FP1 or FP21.

### 3.1.2 Debug Tool Configuration

To debug a user program, use on-chip debug tool (USB Debug Adaptor or MINICUBE2). Debug tools can be used with NEC's development environment (CubeSuite or ID78K0R-QB V3.50 or greater). For option1 board, connect debug tool to the FP1 connector. For option 2 board, connect tool to the FP21 connector.

## 3.2 Power Supply

In debugging mode, the debug tool supplies power to the board through the 16-pin FP1 or FP21 connector unless the tool is configured for power supplied by the target system. To use battery power or an external power source, insert coin cell battery or connect external power supply (maximum 5 volts) to power jack: CON1 or CON21.

## 3.3 Reprogramming the MCU's Flash Memory

The MCU's on-chip flash memory can be reprogrammed any time using debug tool in conjunction with GUI programmer application (QBP for MINICUBE2 or WriteEZ4 for USB Debug Adapter). Connect debug tool to 16-pin interface FP1 (option 1) or FP21 (option 2). When code is downloaded via the debug tool for software evaluation, the flash memory retains the program. To debug another program, erase beforehand the flash memory using the GUI application programmer software.

## 3.4 Measuring MCU Power Consumption

Power select jumper, JP1 or JP21 in option 1 or option 2 respectively, is a dedicated terminal connected to the MCU's $V_{DD}$ pin, $EV_{DD}$ pin and $AV_{REF}$ pin. TP1 and TP2 in option 1 or TP21 and TP22 in option 2 can be connected to an ampere meter to accurately measure MCU power consumption via combination of the power select jumper. The power select jumper has two inserts: pin 1-3 and pin 2-4. Pin 1-3 connects to MCU's $V_{DD}$ pin and pin 2-4 connects MCU's $EV_{DD}$ pin and $AV_{REF}$ pin.

1. In normal mode, pin 1-3 and pin 2-4 are closed.
2. For MCU core current measurement, both pin 1-3 and pin 2-4 are open.
3. By using configuration combinations of pin 1-3 and pin 2-4, different current modes can be measured.
4. Connect in series with an ampere meter on terminals (TP1 and TP2 or TP21 and TP22) to measure current.

**Note**: Additionally removing 0Ω resistor, R9 and R10 in option 1 or R29, R210 and R211 in option 2, individual current can be measured. Refer to section 5 *schematics* for connection details.

**Table 3. Power Jumper Settings**

| Jumper | Status | Current measurement Mode |
|---|---|---|
| 1–3 | CLOSED | Normal program operation |
| 2–4 | CLOSED | |
| 1–3 | OPEN | CPU core current measurement including peripheral current. |
| 2–4 | CLOSED | |
| 1–3 | CLOSED | Bypass ampere meter (Not in current measurement mode) |
| 2–4 | OPEN | |
| 1–3 | OPEN | CPU core current measurement excluding peripheral current |
| 2–4 | OPEN | |

# 4. On-Board Components

## 4.1 16-Pin Debugging and Flash Programming Interface Header

The 16-pin flash programming interface (FP1 or FP21) header is used for connecting the target board to a debug tool for programming of the MCU's flash memory and debugging user programs. For more information about NEC Electronics debug tools, MINICUBE2 or USB Debug Adapter, please refer to the *MINICUBE2 User's Manual* or *EB-USB-DA User's Manual*.

**Figure 4. Signal Assignments for 16-Pin Debugging and Flash Programming Interface Connector**

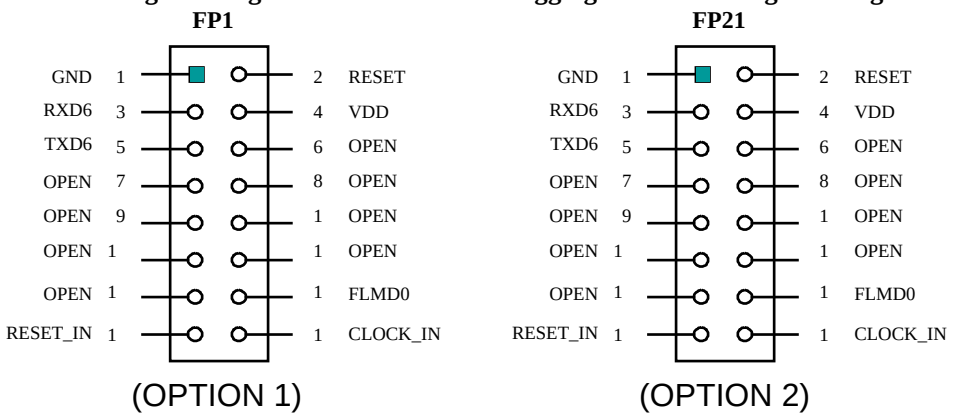



**Table 4. Debugging and Flash Programming Signal Descriptions**

| Pin Number | Name | Function |
|---|---|---|
| 1 | GND | Ground |
| 2 | RESET | Reset sent to the MCU |
| 3 | RXD6 | Receive signal from debugger (Tool 0) |
| 4 | VDD | $V_{DD}$ from the flash debugger/programmer |
| 5 | TXD6 | Transmit signal from debugger (Tool 0) |
| 6 | OPEN | Not in used |
| 7 | OPEN | Not in used |
| 8 | OPEN | Not in used |
| 9 | OPEN | Not in used |
| 10 | OPEN | Not in used |
| 11 | OPEN | Not in used |
| 12 | OPEN | Not in used |
| 13 | OPEN | Not in used |
| 14 | FLMD0 | Programming mode pin |
| 15 | RESET_IN | External reset to the MCU |
| 16 | CLOCK_IN | Clock input for 2-wire mode debug (Tool 1) |

## 4.2 Solder Blobs

### 4.2.1 Normally closed solder blobs (SB)

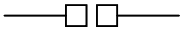
For option 1, the SB1, SB2, SB3, SB4, SB5 and SB 6 are normally closed solder blobs. From SB1 to SB5 solder blobs, connect the programming interface signals to the FP1 and U1 MCU port pins. The SB6 connects between $EV_{DD}$ pin and $AV_{REF}$ pin. For option 2, the SB21, SB22, SB23, SB24, SB25 and SB27 are normally closed solder blobs and SB21 to SB25 connect the programming interface signals to the FP21 and U21 MCU port pins. The SB27 connects between $EV_{DD}$ pin and $AV_{REF}$ pin.

**Figure 5. Normally closed solder blob**

### 4.2.2 Normally open solder blobs (SB)

For option 1, the SB8, SB9, SB10 and SB11 are normally open solder blobs and connect the crystal oscillators: Y1 and Y2 pins. For option 2, the SB28, SB29, SB230 and SB231 are normally open solder blobs and connect the crystal oscillators: Y21 and Y22 pins. By default, oscillators are populated in the target board. These solder blobs are open for the I/O port interface when external oscillators are in use. For MCU's port usage, remove respective oscillator from board and connect with 0Ω resistor. Refer to Section 5 *schematics* for connection details.

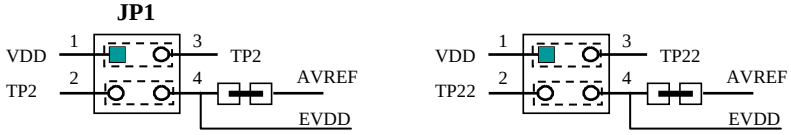
**Figure 6. Normally open solder blob**



## 4.3 Power select jumper

JP1 or JP21 are used for connecting to the MCU's $V_{DD}$ pin, $EV_{DD}$ pin and $AV_{REF}$ pin in option 1 or option 2 respectively. Therefore, any combination of power select jumper pin 1-3 and pin 2-4 can measure the power consumption of MCU. Refer to Table 3 for details about jumper combinations.

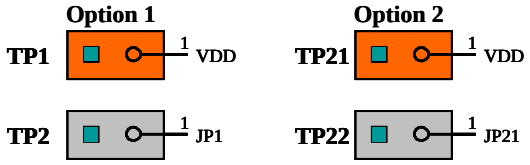
**Figure 7. JP1 and JP21 Configuration**



### 4.4 Test point terminal

TP1 and TP2 in option 1 are used for measuring current in series connection with an ampere meter and TP21 and TP22 are used in option 2 as the same connection.

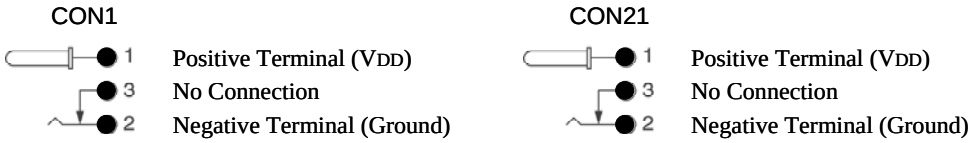
**Figure 8. Test point terminal connection**




### 4.5 VDD Selection

The board can derive power from two sources: battery BAT1 or external power source. The external power can also be supplied from the power jack, an optional component for target board. In debugging mode, power can also be deliver from the debug tool. To avoid charging, remove coin battery from holder BAT1 before external power or debug tool connects to target board.

**Figure 9. Power Jack (optional component)**




**Note**: Maximum Input 5.0 volts at CON1 and CON2.

### 4.6 Main-clock Selection

A resonator oscillator Y2 for option 1 or Y22 for option2 can be used for the main clock. Any resonator oscillator with frequencies ranging from 2 to 20 MHz is recommended. By default, main-clock oscillator is populated.

Note: Refer to the *µPD78F1009 User's Manual* or *µPD78F1014 User's Manual* for information about configuring a driven clock for X1 and X2.

### 4.7 Sub-clock Selection

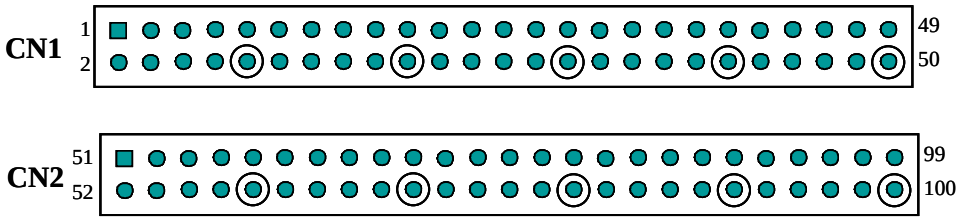
A crystal oscillator Y1 in option 1 or Y21 in option2 can be used for the sub clock. A Seiko SP-T2A Series quartz crystal oscillator or equivalent that uses 6 - to 18-picofarad (pF) biasing capacitors recommended by crystal oscillator manufacturer. By default, Sub-clock oscillator is populated.

Note: Refer to the *µPD78F1009 User's Manual* or *µPD78F1014 User's Manual* for information about configuring a driven clock for XT1 and XT2.

### 4.8 MCU I/O Pin Array

The CN1 and CN2 connectors are pinned out from MCU port pins. These connectors are 0.1 inch pitch 2 row 50 positions connector providing easy access to all I/O pins and can connect to user prototype board.

**Figure 10. I/O Pin Array**




### 4.9 Pushbutton Switches

For option 1, SW1 and SW2 are momentary pushbutton switches. Pressing SW1 connects the MCU's port pin P70 to ground, and pressing SW2 connects the MCU's port pin P71 to ground. P70 and P71 are pulled up externally with 10 kΩ resistor R2 and R3 respectively. For option2, SW21 and SW2 are the same port configuration as SW1 and SW2 pulled up with R22 and R23 respectively.

### 4.10 LED Indicators

For option 1, LED1 and LED2 are red light emitting diodes (LED) and driven by port P50 and P51 respectively. Active low output port turns on the LED. LED21 and LED22 are used in option 2 with same configuration as option 1.

Note: LED's current does not include in power measurement at test point terminals.

### 4.11 Analog port

For option 1, RV1 connect s to port ANI0. Turning RV1 can vary from 0 to VDD volt at ANI0 analog port. RV21 is used for option 2.

## 5. Printed Circuit Board

**Figure 11. Top layer silk screen**

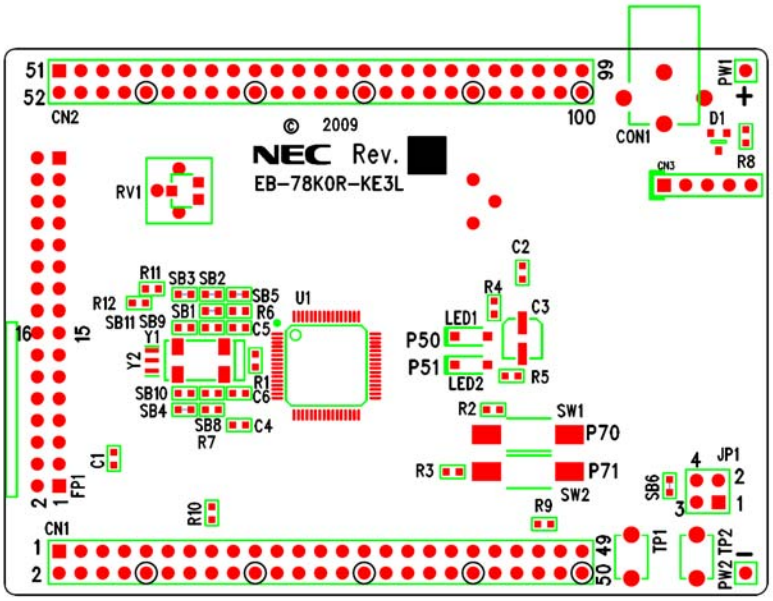
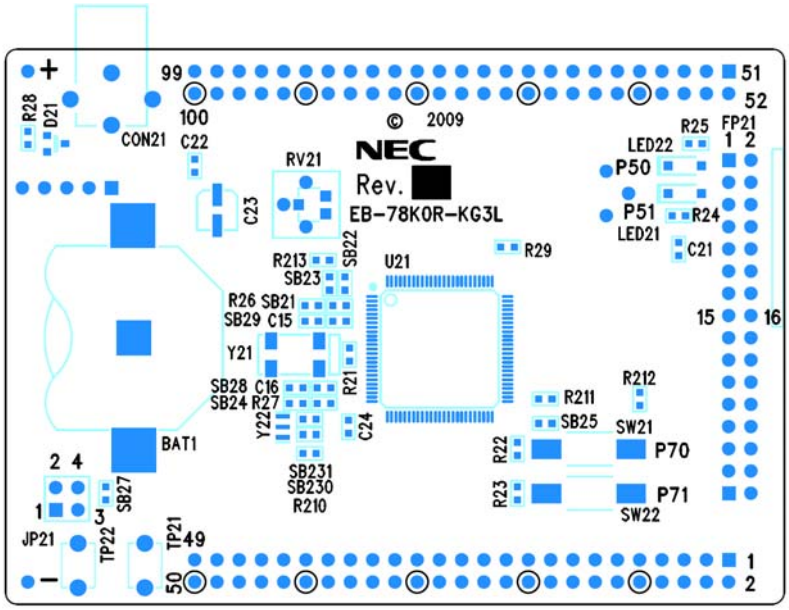
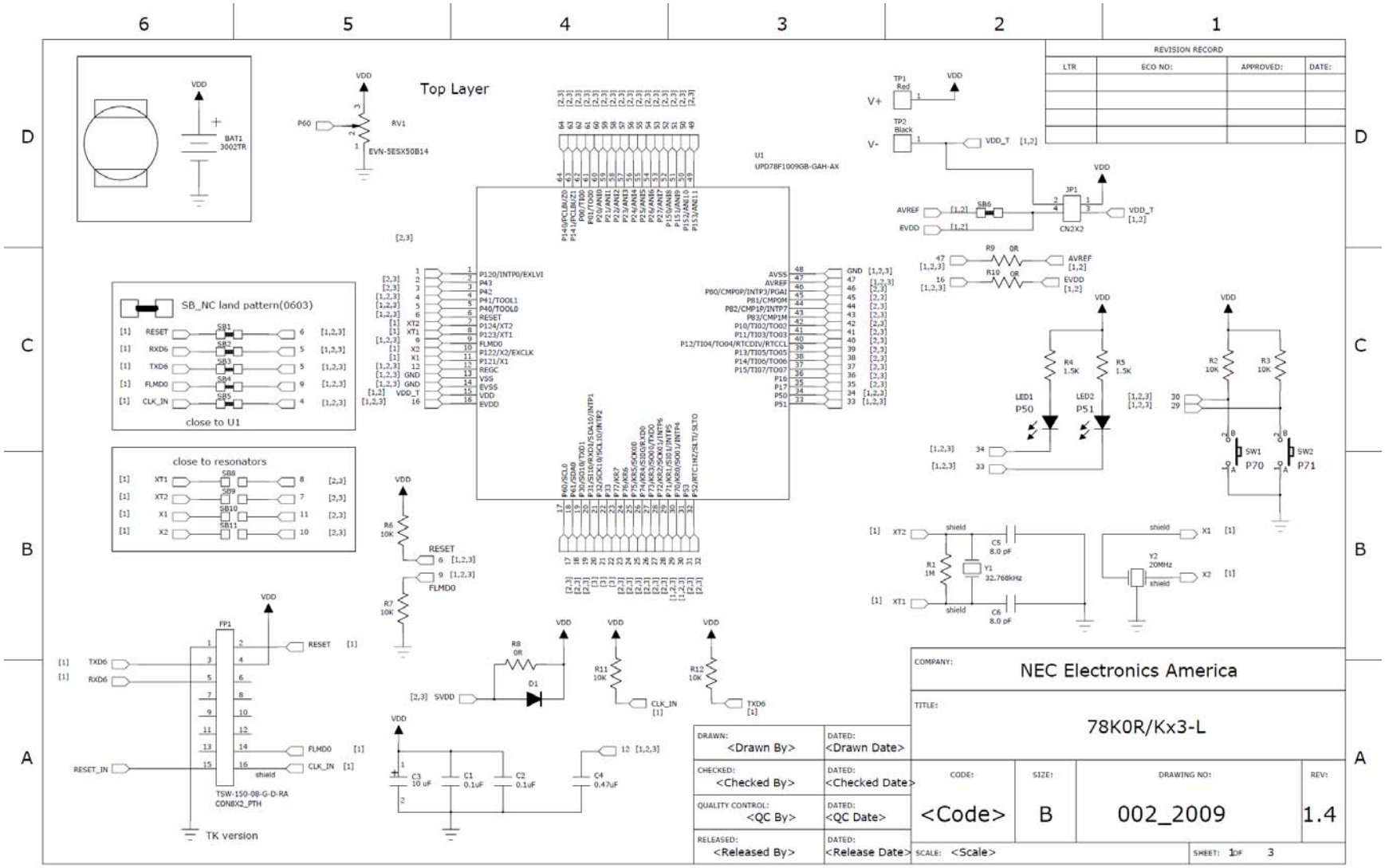
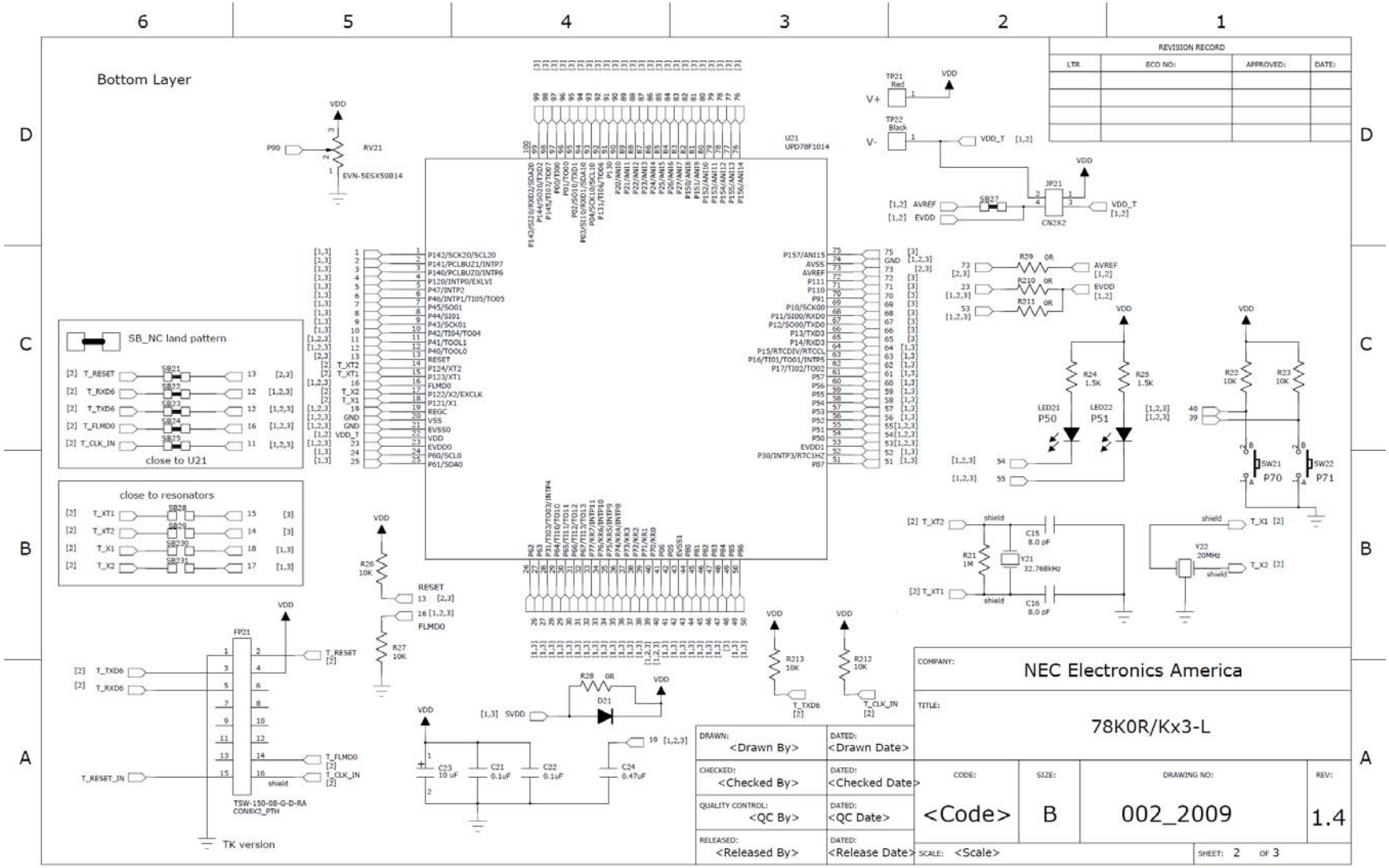



**Figure 12. Bottom layer silk screen**



## 6. Schematics

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close to U21
close to resonators
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U21
UPD78F1014
RV21
EVN-5ESX50B14
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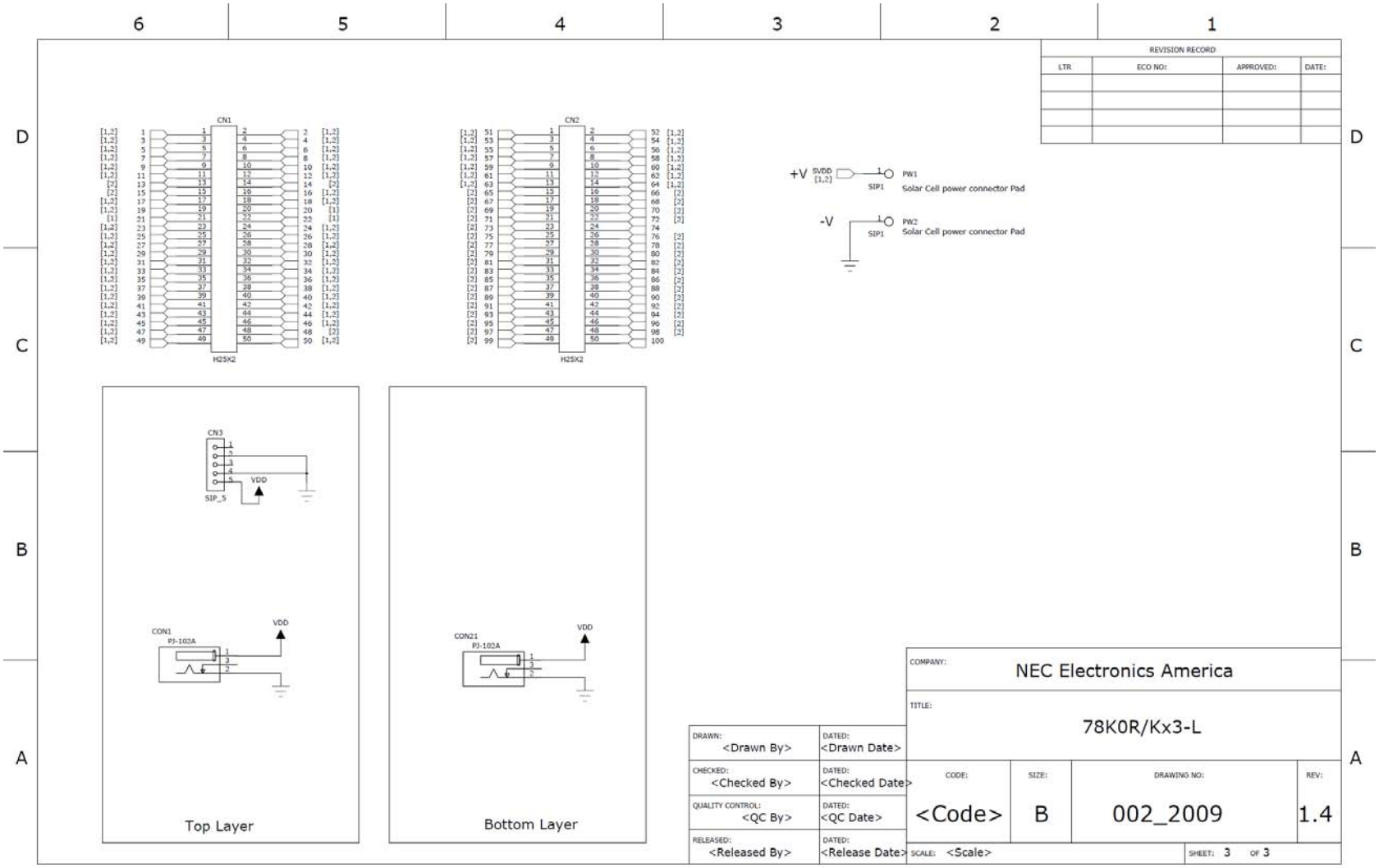
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PJ-102A
VDD
CON21
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VDD
Top Layer
Bottom Layer
DRAWN:
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DATED:
<Drawn Date>
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<Checked Date>
QUALITY CONTROL:
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DATED:
<QC Date>
RELEASED:
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DATED:
<Release Date>
COMPANY:
NEC Electronics America
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78K0R/Kx3-L
CODE:
<Code>
SIZE:
B
DRAWING NO:
002_2009
REV:
1.4
SCALE: <Scale>
SHEET: 3 OF 3

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