User's Manual

MUB-K0-K0S LCD Multi-Use Board

for K0 and K0S Microcontrollers

Document no. 50850-1

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NEC

Introduction 1

This manual contains information about the following:

- MUB-K0-K0S LCD Multi-Use Board (MUB)
- Kit components
- Hardware
- Special features
- Software
- Documentation

1.1 Description

The MUB can be used with the μPD78P0308 and μPD78F9418 LCD versions of the K0 and K0S microcontroller families. It operates as a low-cost standalone unit and has a 4 x 4 switch matrix, an LCD display, and a breadboard area for adding circuitry. By connecting the MUB to a K0 or K0S emulator, you can enter simple commands via the switch matrix and then view the results on the LCD display.

Seven software functions are programmed into the μPD78P0308 microcontroller supplied with the kit. A floppy disk contains sample code, flow charts, and documentation for five μPD789418 software functions, making it easy to adapt the programs to your own design. Simply attach an emulator to the MUB to modify and debug the programs and then use the MUB as a prototype to verify the new code.

1.2 Features

The board's flexible design is suitable for a variety of development tasks.

1. *Demonstrating on-board software applications such as switch-matrix decoding, LCD display, real-time clock, and others.* You may easily use or modify the on-board programs to test and verify your designs.

2. *Measuring microcontroller current consumption.* Voltage across a precision resistor in the microcontroller's voltage supply line can be measured to calculate the microcontroller's current consumption in various operating modes.

3. *Performing in-system programming of the K0S μPD78F9418 flash device.* Example code in the μPD78P0308 microcontroller on the MUB can be used, along with firmware and the MUB's flash programming circuitry, to program the μPD78F9418 K0S flash microcontroller with the software functions described in Section 5. These functions can be used as a basic building block for system programming capability.

4. *Connecting the MUB to a FlashPro programmer.* The MUB can be connected to a FlashPro programmer via its built-in 9-pin connector. (However, the MUB is *not* a production programmer.)

5. *Implementing a breadboard for product design development.* The MUB serves as a breadboard by providing the basic building blocks (such as an LCD display and switch matrix) of a typical microcontroller application. The LCD is removable and can be replaced with a custom LCD. However, due to variations in LCD connections and the lack of a standard, the board cannot be connected universally to all LCD displays. The board also has a breadboard area to which all port signals are readily available. The wire wrap area provides a way to implement special circuitry for target designs.

1.3

Starting Up

The development board is shipped with an LCD display that must be mounted before use.

1. For use with the K0 microcontroller, mount the display in the K0 LCD area (socket **LCD1**).

2. For use with the K0S microcontroller, solder two LCD socket strips to the K0S LCD area (socket **LCD2**). See Section 6 to obtain the part number of the socket strips.

3. The LCD has three round corners and one square corner. Pin 1 of the LCD is diagonally opposite the one square corner (Figure 1-1). To avoid damaging the LCD display, apply finger pressure above the pins of the display and not on the glass.

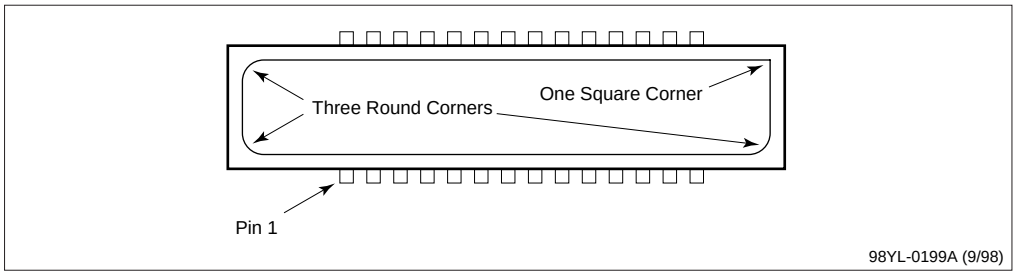
4. To start the board, connect the AC power supply to the J1 power connector.

5. Plug the power adapter into a 110-volt power supply.

6. Verify that the LCD displays **LCD ON** and the 5-volt green LED turns on.

7. Begin operating the unit as described in Section 5.

Figure 1-1. Pin 1 Orientation



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Kit Components 2

The MUB kit contains the following components.

1. One daughterboard with a programmed μPD78P0308GF OTP device and demonstration programs (described in Section 5) The daughterboard is plugged into the MUB and the entire assembly is shipped in an anti-static bag.

2. Second daughterboard without components

3. AC power adapter

4. Schematic, parts list, and assembly drawing

5. *MUB-K0-K0S LCD Multi-Use Board User's Manual* (document no. 50850)

6. Floppy disk containing software routines and flow charts

7. Two user's manuals and five data sheets

    - User's manuals
        - μPD780308
        - μPD78940x/1x
    - Data sheets
        - μPD780306/308
        - μPD78P0308
        - μPD79940x
        - μPD78941x
        - μPD78F9418

The MUB is shipped with everything shown in Figure 3-1, except for the K0 LCC socket, the K0S LCC socket, the K0S clam shell socket, the two RS-232 drivers and connectors, the K0 and K0S headers, and the FlashPro DB9 connector. The part numbers and purchasing information for these items can be found in Section 6.

Go to Section 5 for operating information or read Sections 3 and 4 for information about the hardware.

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Hardware 3

The MUB-K0-K0S Multi-Use Board is a four-layer printed circuit board measuring approximately 8.5 x 8.0 inches (Figure 3-1).

3.1 Sockets and Crystals

3.1.1 μPD78P0308 Device and IE-78001 Emulator

One daughterboard is mounted with a μPD78P0308. A second daughterboard can accept an EV-9200GF-100 LCC socket for the 14 x 20-mm μPD78P0308KL-T LCC EPROM or a μPD78P0308 emulator probe. These sockets provide an inexpensive method of connecting the MUB to an in-circuit emulator, windowed μPD78P0308, or μPD78P0308 OTP device. A 4.19-MHz main clock crystal and 32-kHz subsystem clock crystal are provided on the motherboard.

3.1.2 ND-K941 Emulator

Etch and holes can accept an 80-pin EV-9200GC-80 LCC socket (for a 14 x 14-mm LCC body) or the μPD789418 emulator probe.

3.1.3 μPD78F9418 QFP Device

Etch and holes can also accept one 80-pin test burn-in-type QFP socket (Yamaichi IC-51-0804-956-2) for a 14 x 14-mm μPD78F9418. An on-board 4.19-MHz main clock crystal and 32-kHz subsystem clock crystal are also provided.

3.2 RS-232 Interface

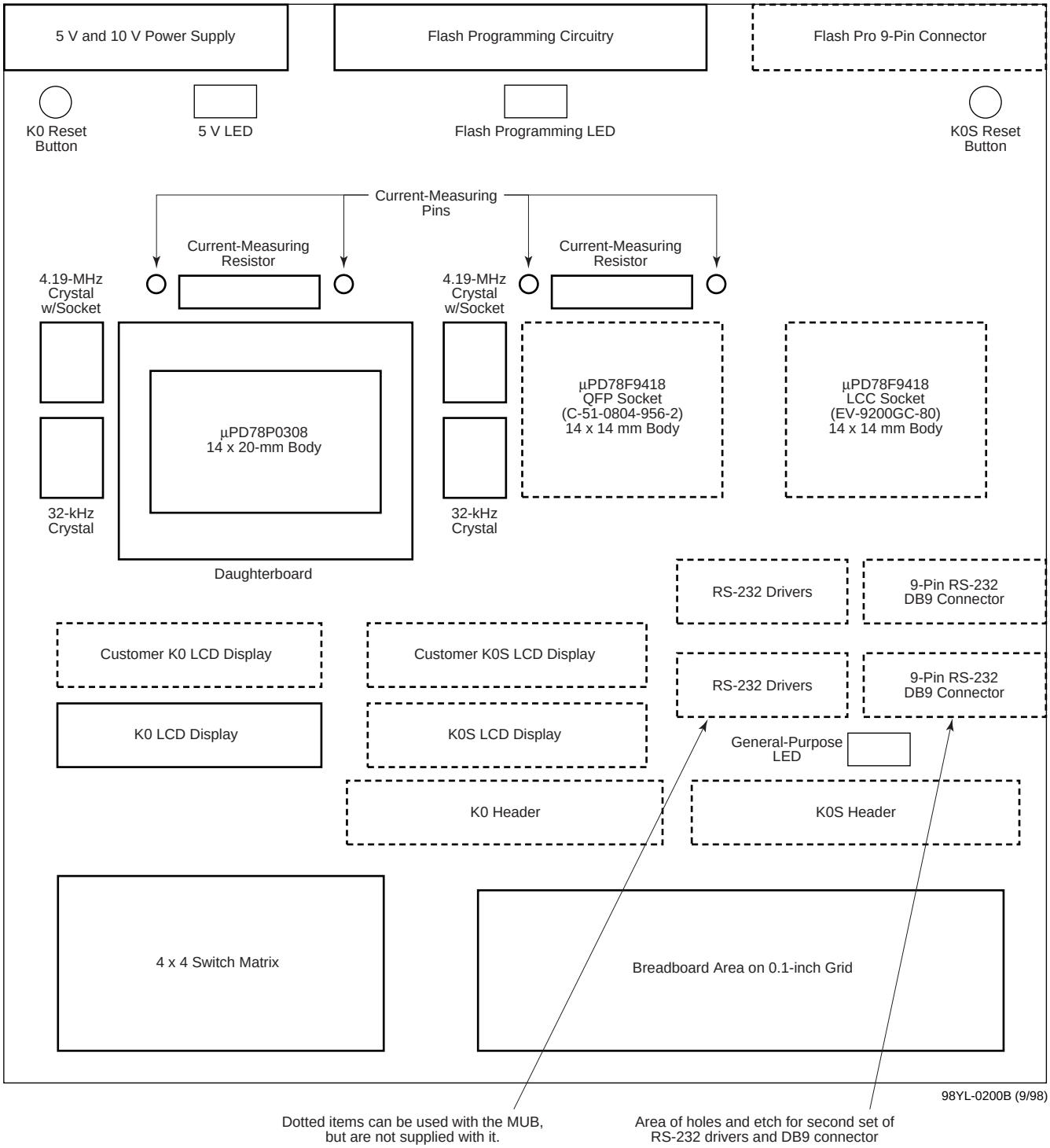
The μPD780308 MUB has two identical sets of UART signals. Each set contains transmit data (TxD), receive data (RxD), request to send (RTS), and clear to send (CTS) signals. The first set is used with all three sockets and the second with the μPD780308 only (Table 3-1).

Table 3-1. Signal Connections

RS-232 Driver Signals	Device	Port	Bits	Pins
TxD1 and RxD1	μPD78P0308	7	1 and 0	4 and 3
TxD and RxD	μPD78F9814	2	1 and 2	55 and 54
RTS1 and CTS1	μPD780308	1	4 and 5	32 and 33
RTS1 and CTS1	μPD78F9418	0	0 and 1	64 and 63
TxD2 and RxD2	μPD780308	11	3 and 4	22 and 23
RTS2 and CTS2	μPD780308	1	6 and 7	34 and 35

There are etch and holes for two sets of RS-232 drivers and two 9-pin, D-shell-type, DB9 RS-232 connectors. Both sets of UART signals have RS-232 drivers that connect the RTS, CTS, TxD, and RxD pins to their respective DB9 connectors. The UART signals connect to standard RS-232 DB9 pins.

Figure 3-1. Block Diagram



3.3 LCD

The MUB has an 8-digit, 7-segment triplex LCD with icons. It is shipped unattached and must be placed in the appropriate socket before operation. The socket labeled **LCD1** is used with the µPD78P0308 and **LCD2** with the µPD78F9418 microcontroller or the K0S emulator. The LCD is mounted for easy removal should you want to replace it with an LCD of your choice.

3.4 4 x 4 Switch Matrix

A 4 x 4 switch matrix can be read using ports from all three microcontrollers (Figure 3-2). The matrix uses the de facto standard row/column configuration, in which no diodes are required.

Figure 3-2. Switch-Matrix Layout

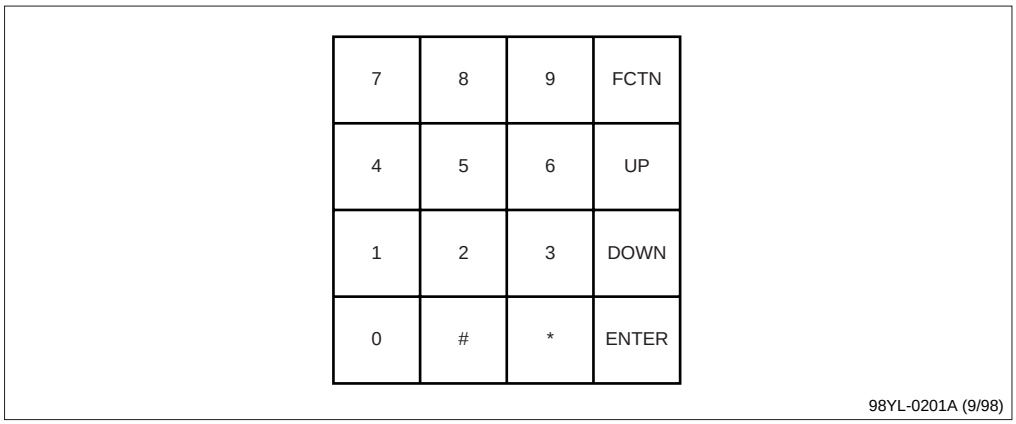


Table 3-2. Switch-Matrix Connections

Device	Column/Row	Port	Bits	Pins
µPD780308	Matrix columns	8	4 to 7	95–92
	Switch rows	8	0 to 3	99–96
µPD78F9418	Switch columns	4	4 to 7	76, 75, 66 and 65
	Switch rows	4	0 to 3	80–77

3.5 Breadboard Area

The breadboard area measures 2 x 4 inches and has holes on a 0.1-inch grid. The hole sizes accommodate standard dual-inline package (DIP) pins. Holes for the headers beside the grid area connect to the port lines from each microcontroller. The +5-volt power supply, ground, and all three microcontroller RESET pins connect to the header.

3.6 Power

The MUB derives power from a 9-volt AC adapter connected to the board. In addition to powering the circuits on the board, the adapter generates 200 mA to power circuitry in the breadboard area and another +10 volts for flash programming.

3.6.1 +5-Volt Power

A 3T regulator generates +5 volts to provide the power for the board.

3.6.2 +10-Volt Power Generation (DC–DC Converter)

A voltage-doubling circuit generates +10 volts from the +5-volt voltage on the MUB. When programming a flash device, the MUB uses the supplied +10 volts and a red LED is on. The LED turns off when programming terminates.

A simple flyback-style, DC–DC converter generates 10 volts for programming K0S flash microcontrollers. (Refer to sheet 1 of the schematic diagram.) L1 and C33 provide a filtered V_{CC} supply for the converter and prevent ripple currents from disrupting other circuits on the board. The L1 DC inductor (choke) provides local filtering; C33 is a bulk storage capacitor that acts as a low-impedance current source for the converter.

Whenever Q9 is on, it pulls one side of L2 to ground, and the voltage across L2 ramps up to 5 volts. When Q9 turns off, its collector flies up and the energy stored in L2 discharges into C34 through the D8 blocking diode. If Q9 is off long enough, the voltage across L2 falls to less than a diode drop. Because Q9 turns on/off in continuous succession, the C34 voltage continues to increase until the feedback control circuit asserts control.

The 555 timer is configured as a free-running stable oscillator and provides a 100-kHz clock source for the Q9 flyback switching transistor. Two NAND gates are configured as a set-reset (SR) latch. A feedback signal from the output of the U7 comparator disables the clocking of Q9 via the SR latch to regulate the output voltage. The U7 comparator provides voltage regulation by comparing a precise DC reference to the scaled output voltage.

The D9 device is a TL431 shunt regulator, a versatile and inexpensive device commonly connected as a resistor-programmable zener reference. In this circuit, D9 is simply connected as a 2.5-volt reference to one input of the comparator.

The R37 and R40 resistors scale the output voltage of the converter for the other comparator input. During regulation, R40 has a 2.5-volt drop and R37 a 7.5-volt drop. The regulated voltage can be adjusted (within limits) by varying the value of R37. The preset value provides the 10 volts needed for programming K0S flash devices.

3.7 Status LEDs

The MUB has three LEDs (Table 3-3).

Table 3-3. LED Functions

LED	Description
Green	Turns on when 5-volt power is supplied
Red	Turns on during flash programming
Yellow	General-purpose LED turned on by logic 0
	In the μPD780308, it is controlled by port 10, bit 0 (pin 38).
	In the μPD78F9418, it is controlled by port 5, bit 0 (pin 60).

3.8 RESET Button

Pressing the **RESET** button resets the corresponding K0 or K0S microcontroller.

3.9 Size

The MUB measures approximately 8.5 x 8.0 inches and has rubber resting pads at each backside corner to elevate the board above its resting surface. A rubber pad in the center of the board serves as mechanical support to prevent breaking or excessive flexing during normal use.

3.10 Development Tools

Isolation for all port pins is implemented in such a way that by cutting one etch, you keep the port pin connected to the headers near the breadboard area and disconnect it from any other on-board circuits.

Two holes in the etch of any port share pins with an on-chip peripheral. The etch between the holes is connected, and the hole size accepts wire wrap pins soldered to the MUB. If you cut the etch between the wire wrap holes, the port signal remains connected to the headers but not to any other on-board devices. The signals can be reconnected to circuitry using the provided holes, wire wrap pins, and wire wrap.

3.11

Flash Programming

The µPD78F9418 mounted on the MUB can be programmed using a Flashpro programmer. The µPD78F9418 can also be programmed by the µPD78P0308.

3.11.1 Connector for Flashpro Programmer

Adding a 9-pin male D-shell connector to the MUB enables you to connect the µPD78F9418 QFP device to a Flashpro programmer (Table 3-4).

3.11.2 Flash Programming Circuit: V_{PP} Control Circuit

Table 3-4. FlashPro Programmer Connections

Connector Pin	Pin on µPD78F9418	Signal Name
1	70	V_{DD0} Ground
2	54	SO/TxD
3	55	SI/RxD
4	56	SCK
5	–	–
6	67	RESET
7	71	V_{DD}
8	74	V_{PP0}
9	–	External V_{PP2}

The VPP switching circuit, shown on sheet 1 of the schematic diagram, has two input control signals from the K0 controller (Table 3-5).

Table 3-5. V_{PP} Input Control Signals

Input Signal	Description
V_{PP}_ENABLE	Allows a non-zero voltage to be applied to the K0S V_{PP} pin
V_{PP}_10V	Controls the applied non-zero voltage to be V_{CC} or +10 volts

A P-channel MOSFET (Q2) switches VPP to 10 volts when VPP_10V is high. For example, if Q2 is not in the circuit, a pair of emitter followers (Q4 and Q7) can be connected so that the emitter of Q7 nearly equals the output voltage from the U8D NAND gate. If the NAND output is VCC, the emitter of Q4 is a diode drop above VCC, and the emitter of Q7 a diode drop below its base voltage, or at VCC. The same applies when the NAND output is low; the emitter of Q7 is zero, pulled to ground by R26.

The NAND output is always equal to control signal VPP_ENABLE. The two intervening inversions (Q8 and the NAND) only serve to provide drive for LED D10. Also, when VPP_ENABLE is 0, diode D6 asserts direct control over Q3 to turn off MOSFET Q2, regardless of the state of signal VPP_10V.

If VPP_ENABLE is 1, then VPP_10V determines whether MOSFET Q2 is on or off. If VPP_10V is 0, then VPP equals VCC. If VPP_10V is 1, then Q2 is on, pulling VPP to 10 volts and cutting off Q7. When VPP_10V switches from 1 to 0, resistor R26 pulls down VPP until Q7 asserts control.

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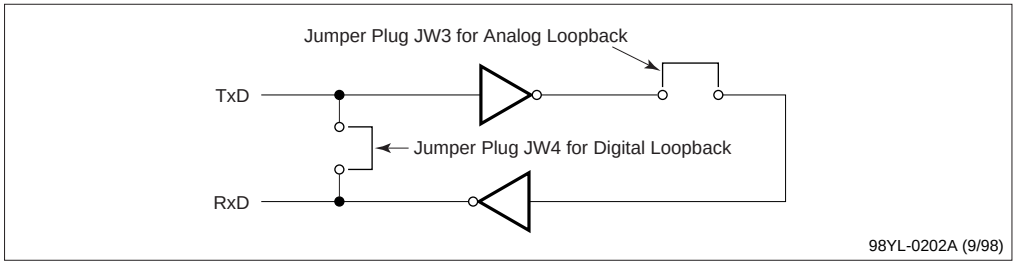
Special Features 4

4.1 Loopback Test

The board has two jumper plugs, JW3 and JW4. The digital JW4 loopback jumper plug connects the microcontroller's TxD output to the device's RxD input. The analog JW3 loopback jumper plug connects the TxD output to the RS-232 driver's RxD input (Figure 4-1). The TxD1 and RxD1 signals derive from the first set of UART signals, common to all three sockets.

Figure 4-1. Loopback Configuration



4.2 Resistors

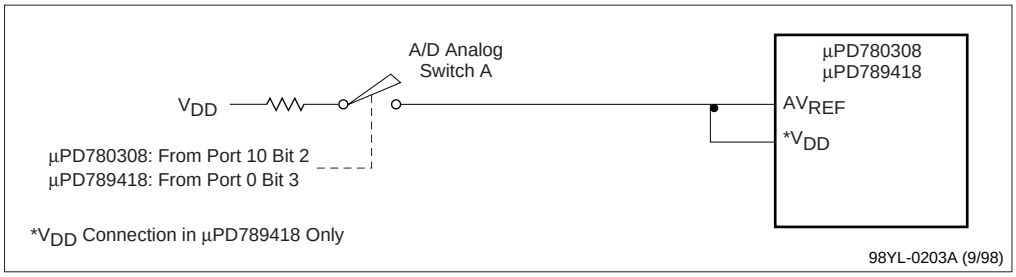
The µPD78P0308 device and µPD789418 microcontrollers have a 100-ohm resistor in series with the V_{DD} supply etch to each of the microcontrollers. A connection at both ends of the resistor enables voltage across the resistor in the V_{DD} line to be measured with a meter and then used to calculate the microcontroller's current consumption. The voltage across JW1 is used to measure the µPD78P0308 and the voltage across JW2 to measure the µPD78F9818. (Please note that the jumper plugs on JW1 and JW2 must be removed before operating current can be measured.)

The LCD bias network (resistors R44–R47 in K0 microcontrollers and resistors R16, R24, R28, and R33 in K0S microcontrollers) draws about 142 µA of current. To measure the current used by the µPD78P0308 microcontroller, put the device in one of the four low-power modes and then remove R44 from its socket. The LCD display turns off, excluding the bias resistors' current consumption from being measured. To measure current consumption for the µPD78F9418, follow the same procedure, removing resistor R16 from its socket. In both cases, replacing the resistor and resetting the microcontroller returns the device to normal operation.

4.3 A/D Converter Power

Voltage to the A/D converter is controlled using a switch, as shown in Figure 4-2 (a functional representation, not the actual circuit implementation). When the multi-use board has power applied, its A/D voltage is grounded. The A/D reference voltage (AV_{REF}) can be turned on by closing switch A. One output from each of the three sockets connects to the switches. In the µPD780308, port 10, bit 2 (pin 41) switches AV_{REF}. In the µPD78F9418, port 0, bit 3 (pin 61) controls AV_{REF} and V_{DD}. Logic 0 from the port pins turns on the switch.

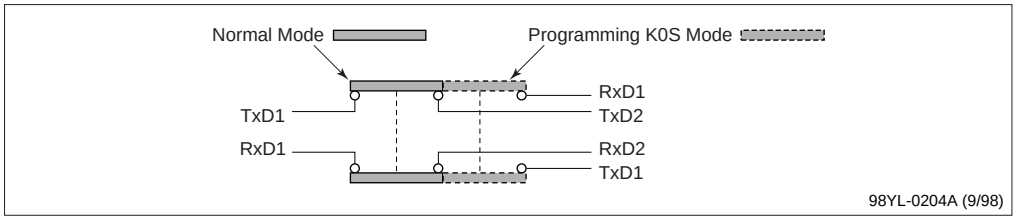
Figure 4-2. A/D Converter Power Control



4.4 Programming the µPD78F9418 Using the µPD780308

In normal operation, TxD of the µPD780308 connects to TxD of the µPD78F9418, and RxD of the µPD780308 to RxD of the µPD78F9418. During programming, TxD of the µPD780308 must connect to RxD of the µPD78F9418 and TxD of the µPD78F9418 to RxD of the µPD780308 by means of a slide switch (Figure 4-3).

Figure 4-3. Slide Switch for K0S Flash Programming



Programming the µPD78F9418 from the µPD780308 requires the µPD780308 to control the RESET and V_{PP} inputs of the µPD78F9418. Port 11, bit 7 of the µPD780308 controls the µPD78F9418's RESET signal (pin 67). A logic 0 on this pin resets the µPD78F9418.

The µPD78F9418's V_{PP} signal (pin 74) is controlled by two signals from the µPD780308: V_{PP}_ENABLE (port 11, bit 6) and V_{PP}_10V (port 10, bit 3). The V_{PP} signal for flash programming turns on when V_{PP}_ENABLE = 1. When bit 6 = 0, then V_{PP} = 0 volts. When bit 6 = 1, then the value of V_{PP} depends on the setting of V_{PP}_10V: logic 0 sets V_{PP} to 5 volts and logic 1 sets it to 10 volts.

To program the µPD78F9418, first set V_{PP}_10V to 1 and V_{PP}_ENABLE to 1 to ensure that V_{PP} goes from 0 volts to 10 volts when V_{PP} is turned on. Then use V_{PP}_10V to control V_{PP} . The V_{PP} pin must be pulsed in order to program the µPD78F9418; the number of pulses depends on the serial programming mode used. (See NEC's programmable protocol document for a description of how to program flash devices.)

4.5 Adding a Custom LCD

The MUB contains an eight-digit, seven-segment display that can be removed easily and replaced with a custom LCD display using ribbon cables.

4.5.1 Adding a K0 LCD

1. Solder a 44-pin ribbon cable connector to position JP4 of the board in the area labeled **K0 EXTERNAL LCD**.

2. Connect one end of a 44-pin ribbon cable to the board.

3. Connect the other end to the custom LCD display.

4. Ensure that all 40 LCD segment lines and four common lines are properly connected to JP4 on the board.

4.5.2 Adding a K0S LCD

1. Solder a 32-pin ribbon cable connector to position JP5 of the board in the area labeled **K0S EXTERNAL LCD**.

2. Connect one end of a 32-pin ribbon cable to the board.

3. Connect the other end to the custom LCD display.

4. Ensure that all 28 LCD segment lines and four common lines are properly connected to JP5 on the board.

When adding a custom LCD, it may be necessary to adjust the voltage drive level to the LCD. A resistor ladder sets NEC's LCD drive voltage. In the case of the K0 device, resistor R44 can be changed to adjust the drive level. To change the entire resistor ladder, replace resistors R44–R47 for the K0 LCD. When working with the µPD789418 K0S device, resistors R16, R24, R28, and R33 can be changed. Also, the resistor biasing can be changed from the current one-third bias to one-half bias, as described in the user's manual for your selected device.

4.6 General-Purpose LED

The amber general-purpose LED turns on when port 10, bit 0 of the µPD78P0308 is set to logic 0 and turns off when the bit is set to logic 1. Port 5, bit 0 of the µPD789418 controls the general-purpose LED.

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Software Functions 5

The µPD78P0308 has seven preprogrammed software functions and the µPD78F9418 has five:

- LCD display
- Time of day
- Power modes
- Switch matrix
- UART loopback mode
- On-chip RAM execution (not in µPD78F9418)
- Flash self-program (not in µPD78F9418)

The development kit contains a flow chart and detailed code for each function.

5.1 Power-On Message

When power is first applied to the board, the LCD displays Lcd On. This message remains on the display until you press the **FCTN** key to remove it.

5.2 Function Menu

The **Function** menu contains the selections shown in Table 5-1 and described in Table 5-2.

Table 5-1. Function Menu

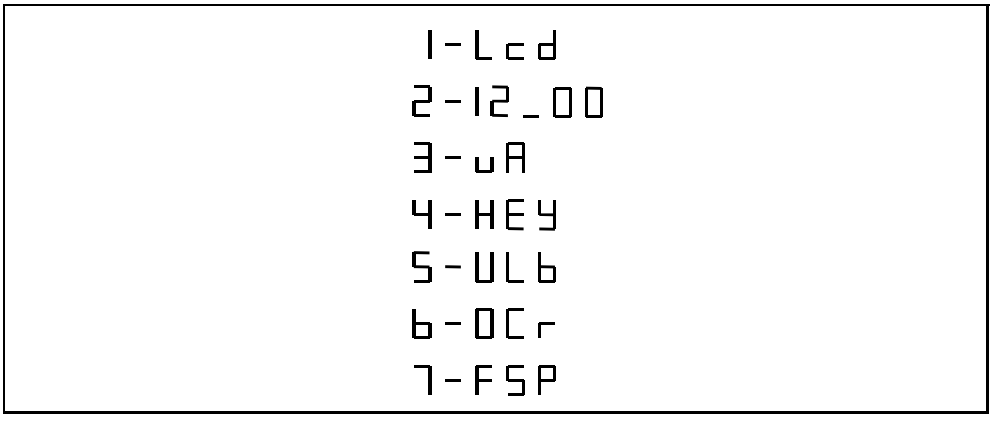


Table 5-2. Description of Functions

Number	Symbol	Description
1	LCD	LCD display
2	12:00	Time of day
3	µA	Power mode
4	Key	Switch matrix
5	ULB	UART loopback mode
6	OCR	On-chip RAM execution
7	FSP	Flash self-program

5.2.1 Selecting a Function

Functions can be selected in one of two ways: using the **FCTN** key or using number keys.

5.2.1.1 Using the FCTN Key

1. Press **FCTN** to display the first function.
2. Press **UP** or **DOWN** to scroll through the **Function** menu (from 1 through 7).
3. Press **FCTN** to select the displayed function.
4. Wait for the LCD to display the related symbol (see Table 5-1).
5. Press **Enter** to start the function.

5.2.1.2 Using Number Keys

1. Press the number key corresponding to your selection.
2. Wait for the LCD to display the related symbol (see Table 5-1).
3. Press **Enter** to start the function.

5.3

Error Message

Entering an invalid number causes the LCD to display Error. To correct the error, press **FCTN** and re-enter the valid number.

Please note that pressing **FCTN** while a function is executing (except during switch-matrix and power mode functions) causes that function to abort and the board to return to the **Function** menu.

5.4
Operation

5.4.1 LCD Display

This function causes the LCD display to rotate the numbers 0 through 9 from right to left in "ticker tape" fashion. At the same time, the icons blink on and off at a rate of once per second.

5.4.2 Time of Day

The time-of-day function tracks and displays the time of day in hours, minutes, and seconds using the 24-hour format. The time is updated once per second.

1. From the **Function** menu, select **2**.
2. Wait for the LCD to display ––_––_––.
3. While the first dash is blinking, enter the first digit of the hours value (0, 1, or 2).
4. When the second dash starts blinking, enter the second digit of the hours value (0–9).
5. For each remaining blinking dash, enter a valid digit for the minutes and seconds values.
6. When all positions are filled, press **Enter** to start the time-of-day function.
7. If the display shows a blinking dash rather than the time of day, repeat steps 1–6, taking care to enter valid digits at each step.

5.4.3 Selecting Power Modes

There are four power mode choices within this function (Table 5-3).

Table 5-3. Power Modes Menu

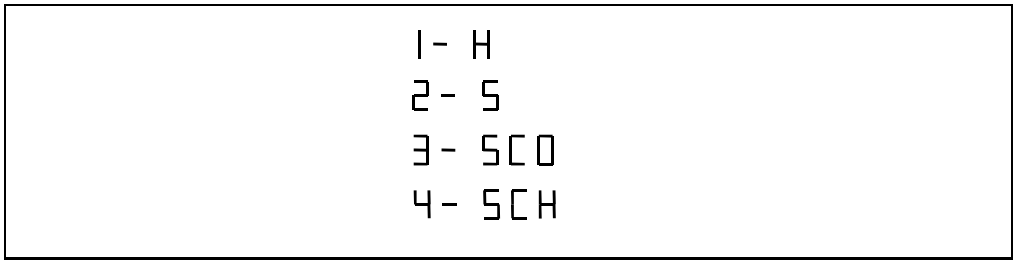


Table 5-4. Description of Power Modes

Number	Symbol	Description
1	H	Halt
2	S	Stop
3	SCO	Subclock operation
4	SCH	Subclock halt

Power modes can be selected in one of two ways: using **UP** and **DOWN** keys or number keys.

5.4.3.1 Using UP and DOWN Keys

1. Use the **UP** and **DOWN** keys to scroll through the selections.
2. Select a number (1–4).
3. Wait for the LCD display to show the corresponding symbol (Table 5-3).
4. Press **Enter** to start the function.
5. Press **Reset** to exit the power mode function.

5.4.3.2 Using Number Keys

1. Press **1**, **2**, **3**, or **4** to make your selection.
2. Wait for the corresponding function symbol to be displayed (Table 5-4).
3. Press **Enter** to start the function.
4. Press **Reset** to exit the power mode function.

5.4.4 Switch Matrix

This function causes the LCD to display a symbol whenever you press a switch key (Table 5-5).

Table 5-5. Switch-Matrix Symbols

Key	Symbol
FCTN (Note)	Fcn
UP	UP
DOWN	dn
ENTER	En
Pound (#)	Pound
Asterisk (*)	AS

Note: Pressing **FCTN** two consecutive times terminates the switch matrix function.

5.4.5 UART Loopback

This function causes the on-chip UART to transmit, receive, and check data bytes 00H, 01H, and 02H to FFH at a speed of 19.2 Kbaud. During this test, the general-purpose LED blinks on and off once per second. Upon reaching the last address (FFH), the microcontroller starts sending data again, beginning at address 00H. Each byte received is compared to the transmitted data byte.

1. If the data is received correctly, the LCD displays Good.
2. If an error is encountered, the LCD displays bAd.

5.4.6 On-Chip RAM

On-chip RAM is available with the µPD78308 or µPD78P0308 only.

This mode loads a program into the 1K internal expansion RAM and then branches the PC to the RAM area to execute the program.

1. Select **6** from the **Function** menu.
2. Press **Enter** to load the program into RAM.
3. Wait for the LCD to display **100**.
4. Press **Enter** to decrement the program counter, one count per second, until it reaches 0.
5. One second after the program counter reaches 0, the LCD displays End.

5.4.7 Flash Self-Program

This function uses the on-board µPD78P0308's on-chip ROM to program an optional on-board µPD78F9418 K0S flash microcontroller with the LCD display function, the time-of-day function, the power mode function, the switch-matrix function, and the UART loopback mode.

The architectures of the K0 and the K0S microcontrollers are different. For one thing, the latter's instruction set is a subset of the former. For another, the K0 device has four register banks, while the K0S device has one. Because of these differences, the same five functions are rewritten as five new functions and then programmed into the K0S flash device.

The µPD78F9418 is programmed by the µPD78P0308 using the three-wire serial I/O mode.

1. Remove jumpers JW3 and JW4 before initiating the program function.
2. Select **7** from the **Function** menu.
3. Wait for the LCD to display rEAdY.
4. Press **Enter** to start the programming.
5. Wait for the LCD to display Prog On and then set the programming switch from the **Serial Comm** position to the **Program K0S** position.
6. If any start-up problems occur, the LCD displays Error. Press **FCTN** to abort the operation. Otherwise, proceed to step 7.
7. Check and display the device number in the programming socket (silicon signature).
8. Wait for the LCD to display SS-Good. If it displays SS-bAd, press **FCTN** and repeat steps 1 through 7 again.
9. Perform a blank check to ensure that the device has been erased.
10. Wait for the LCD to display bL Good and then proceed to step 12.
11. If the chip is not blank, it will be erased automatically by the µPD78P0308.

12. If erasure is successful, the LCD displays ErASE.

13. If it is unsuccessful, the LCD displays Error. In that case, press **FCTN** to abort the operation.

14. Program the device with the program in the µPD78P0308's ROM.

15. The LCD displays a five-second status message at each interval and then automatically proceeds to the next step (Table 5-6).

16. If the LCD displays Error, press **FCTN** to abort the operation.

17. Read and compare each byte in the programmed device to ensure that it is correctly programmed.

18. When the LCD displays ProG OFF, set the switch from the **Program K0S** position to the **Serial Comm** position.

19. Press **FCTN** to terminate the programming function.

Table 5-6. Programming Status Messages

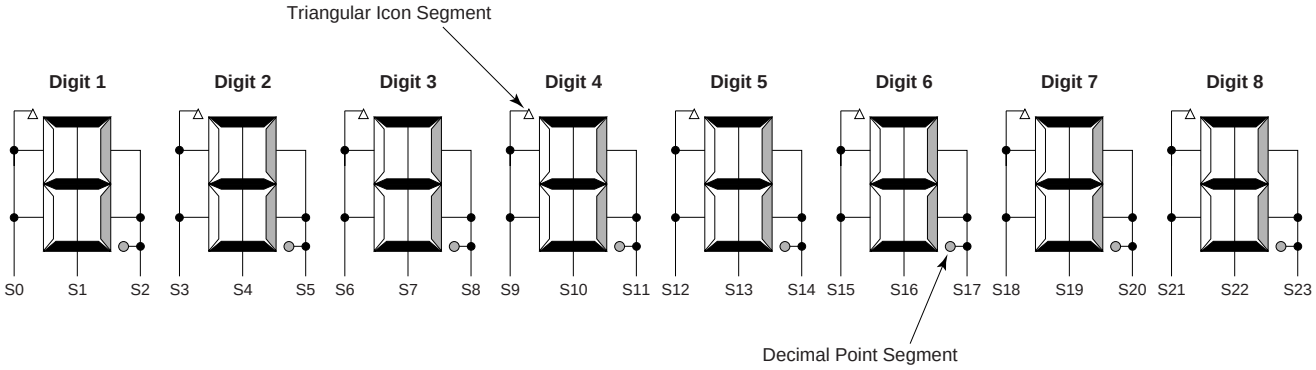
	Message	
Step	**Successful**	**Unsuccessful**
Erase	ErASE	Error
Programming	ProG	Error
Verify	UEriFY	Error
Programming result	Good	bAd

NEC

Documentation 6

This section contains the MUB schematic, parts list, and layout. It also contains the flow charts and source code for the MUB.

Figure 6-1. LCD Wiring Diagram



Notes: 1. LCD Digit 1: Segments in white are controlled by S0.
Segments in black are controlled by S1.
Segments in gray are controlled by S2.
2. Digits 2–8 are controlled in a similar manner to digit 1.

98YL-0206B (9/98)

Bill of Materials

Table 6-1. Main Board Assembly

Item	Qty.	Description	Reference Design	Orde Numberr
1	1	Circuit board: MUB main; bare; 4-layer	N/A	N/A
2	4	22pF monolithic ceramic capacitor: 100V 5%, radial	C11, C13, C30, C32	Digi-Key P4841-ND
3	4	33pF monolithic ceramic capacitor: 100V 5%, radial	C10, C12, C29, C31	Digi-Key P4843-ND
4	1	560pF monlithic ceramic capacitor: 100V 5%, radial	C37	Digi-Key P4858-ND
5	14	1nF monolithic ceramic capacitor: 50V 5%, radial	C6, C7, C8, C21, C24, C25, C26, C27, C35, C36, C38, C39, C40, C43	Digi-Key P4937-ND
6	6	1uF electrolytic capacitor: 50V 20%, radial	C5, C9, C14, C22, C23, C28	Digi-Key P6260-ND
7	1	10uF electrolytic capacitor: 50V 20%, radial	C20	Digi-Key P6264-ND
8	1	47uF electrolytic capacitor: 25V, radial	C33	Digi-Key P6238-ND
9	1	100 uF electrolytic capacitor: 25V, radial	C17	Digi-Key P6239-ND
10	1	220uF electrolytic capacitor: 16V, radial	C34	Digi-Key P6228-ND
11	1	LED: red, 5 mm, diffused, radial lead	D7	Digi-Key LT1124-ND
12	1	LED: yellow, 5 mm, diffused, radial lead	D1	Digi-Key LT1133-ND
13	1	LED: green, 5 mm, diffused, radial lead	D4	Digi-Key LT1130-ND
14	3	1N4148 diode: 100V, 500 mW	D2, D5, D6	Digi-Key 1N4148DICT-ND
15	1	1N4001 rectifier: 1A, 50 PIV	D3	Digi-Key 1N4001DICT-ND
16	1	1N5818 Schottky rectifier: 1A, 30V	D8	Digi-Key 1N518CT-ND
17	2	2 x 15 dual-row male header (break to length)	JP1A, JP1C	Digi-Key S2011-36-ND (2x36 strip)
18	2	2 x 10 dual-row male header (break to length)	JP1B, JP1D	Digi-Key S2011-36-ND (2x36 strip)
19	3	Header: male, 2-pin	JW1, JW2, JW4	Digi-Key 929647-09-36-ND (36-pin strip)
20	3	Shunt (jumper plug)	JW1, JW2, JW4	Digi-Key 929955-06-ND (strip of 10)
21	1	Power jack: 2.0 mm, male, open	J1	Digi-Key CP-003A-ND
22	1	LCD: Excel Technology 8313-RPH-0.25	LCD1	Excel Technology 8313-RPH-0.25
23	2	Socket strip: 0.1-inch pitch, 14-pin (break to length)	LCD1 location	Digi-Key ED7064-ND (64-pin strip)
24	2	100 uH choke: 250 mA DC min. rating	L1, L2	Mouser 434-23-101
25	4	NPN transistor: 2N4401	Q3, Q7, Q8, Q9	Digi-Key 2N4401
26	3	PNP transistor: 2N4403	Q1, Q4, Q5	Digi-Key 2N4403
27	1	P-channel MOSFET: internal rectifier IRFD9110	Q2	Digi-Key IRFD9110-ND
28	3	Zero ohm resistor: 1/4 W, axial-leaded	R7, R17, R31	Digi-Key 0.0QBK-ND
29	3	100 5% resistor: 1/4 W, axial-leaded	R4, R15, R25	Digi-Key 100QBK-ND
30	1	220 5% resistor: 1/4 W, axial-leaded	R38	Digi-Key 220QBK-ND
31	4	330 5% resistor: 1/4 W, axial-leaded	R1, R2, R10, R30	Digi-Key 330QBK-ND
32	8	1.0K 5% resistor: 1/4 W, axial-leaded	R3, R6, R19, R20, R23, R36, R41, R42	Digi-Key 1.0KQBK-ND
33	2	2.2K 5% resistor: 1/4 W, axial-leaded	R26, R27	Digi-Key 2.2KQBK-ND
34	1	3.3K 5% resistor: 1/4 W, axial-leaded	R43	Digi-Key 3.3KQBK-ND
35	5	4.7K 5% resistor: 1/4 W, axial-leaded	R14, R16, R18, R34, R44	Digi-Key 4.7KQBK-ND
36	9	10K 5% resistor: 1/4 W, axial-leaded	R5, R12, R21, R24, R28, R33, R45, R46, R47	Digi-Key 10.0QBK-ND
37	1	22K 5% resistor: 1/4 W, axial-leaded	R13	Digi-Key 22.0KQBK-ND

Table 6-1. Main Board Assembly (continued)

Item	Qty.	Description	Reference Design	Orde Numberr
38	2	100K 5% resistor: 1/4 W, axial-leaded	R9, R11	Digi-Key 330KQBK-ND
39	2	330K 5% resistor: 1/4 W, axial-leaded	R8, R32	Digi-Key 100KQBK-ND
40	1	2.49 1% resistor: 1/4W, axial-leaded	R40	Digi-Key 2.49KXBK-ND
41	1	7.50K 1% resistor: 1/4 W, axial-leaded	R37	Digi-Key 7.50 KXBK-ND
42	18	Pushbutton: Panasonic EVQ-QS205K	SW1, DW2, SW3, SW4, SW5, SW6, SW7, SW8, SW9, SW10, SW11, SW12, SW13, SW14, SW15, SW16, SW17, SW18	Digi-Key P8037S-ND
43	1	Slide switch: DPDT, right angle, E-switch EG2215	SW19	Digi-Key EG1909-ND
44	1	IC: 5V positive regulator 78M05, TO-220	U6	Digi-Key NJM78M05FA
45	1	IC: dual comparator LM393A, 8-DIP	U7	Digi-Key LM393N
46	1	IC: quad 2-input NAND, 74HCT00, 14-DIP	U8	Digi-Key CD74HCT00E
47	1	IC: timer, LM555, 8-DIP	U9	Digi-Key LM555CN
48	1	IC: adjustable shunt regulator, TL431CLP, TO-92	U10	Mouser 511-TL431-CZ
49	2	4.19-MHz ceramic resonator	Y1, Y3	Digi-Key X912
50	2	32.768-kHz cyl. crystal: Epson C-001R 32.768K-A	Y2, Y4	Digi-Key SE3201-ND
51	8	Rubber feet: tall, tapered, square		Digi-Key SJ5518 (pad of 6)

Table 6-2. Main Board Options

Item	Qty.	Description	Reference Design	Order Number
LCD for K0S Microcontrollers				
1	1	LCD: Excel Technology 8313-RPH-0.25	LCD2	Excel Technology 8313-RPH-0.25
2	2	Socket strip: 0.001” pitch, 14-pin (break to length)	LCD2 location	Digi-Key ED7064-ND (36-pin strip)
Primary Serial Port				
3	1	MAX232 IC: RS-232 level shifter, DIP	U5	Digi-Key MAX232CPE-ND
4	4	10 uF electrolytic capacitor: 50 V, 20% radial	C15, C16, C18, C19	Digi-Key P6264-ND
5	1	Header: male, 2-pin (for analog loopback)	JW3	Digi-Key 929647-09-36-ND (36-pin strip)
6	1	DB9 receptacle: right-angle PCB	P3	Mouser 152-3409
Secondary Serial Port				
7	1	MAX232 IC: RS-232 level shifte, DIP	U4	Digi-Key MAX232CPE-ND
8	4	10 uF electrolytic capacitor: 50 V, 20% radial	C1, C2, C3, C4	Digi-Key P6264-ND
9	1	DB9 receptacle: right-angle PCB	P3	Mouser 152-3409
Emulation Adapter Socket for K0 Microcontrollers				
10	1	µPD78P0308KL-T 14 x 20-mm LCC socket	U1	NEC socket EV-9200GF-100
Programming Socket for K0S Microcontrollers				
11	1	Test socket: µPD78F9418 QFP	U2	Yamaichi IC51-0804-956-2
Emulation Adapter Socket for K0S Microcontrollers				
12	1	LCC socket for NEC ND-K941 emulator	U3	NEC socket EV-9200GC-80
FlashPro Connector				
13	1	DB9 plug: right-angle PCB, FlashPro connector	P2	Mouser 152-3309
Other				
14	1	Optional AVCC scaling resistor: 1/4 W leaded	R22	Optional, Value TBD, 1/4 W

Table 6-3. Daughterboard Assembly

Item	Qty.			
1	1			
2	2			
3	2			
4	2			
5	1			

Table 6-4. Miscellaneous Packout Materials

Item	Qty.			
1	1			
2	1			
3	1			
4	1			