

DEMO908LB8

Demonstration Board for Freescale 68HC908LB8

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REVISION

Date	Rev	Comments
March 24, 2005	A	Initial Release

CAUTIONARY NOTES

- 1) Electrostatic Discharge (ESD) prevention measures should be used when handling this product. ESD damage is not a warranty repair item.
- 2) Axiom Manufacturing does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under patent rights or the rights of others.
- 3) EMC Information on the DEMO908LB8 board:
 - a) This product as shipped from the factory with associated power supplies and cables, has been verified to meet with requirements the FCC as a CLASS A product.
 - b) This product is designed and intended for use as a development platform for hardware or software in an educational or professional laboratory.
 - c) In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate prevention measures.
 - d) Attaching additional wiring to this product or modifying the products operation from the factory default as shipped may effect its performance and cause interference with other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures should be taken.

TERMINOLOGY

This development board uses option selection jumpers. A jumper is a plastic shunt that connects 2 terminals electrically. Terminology for application of the option jumpers is as follows:

Jumper on, in, or installed - jumper is installed such that 2 pins are connected together.

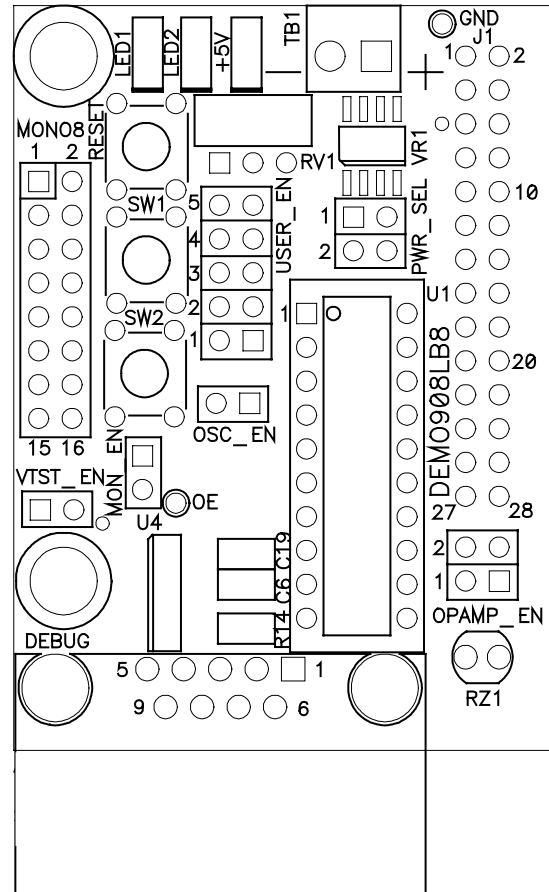
Jumper off, out, or idle - jumper is installed on 1 pin only. It is recommended that jumpers be idled by installing on 1 pin so they will not be lost.

FEATURES

The DEMO908LB8 is an evaluation or demonstration board for the Freescale 68HC908LB8 microcontroller. Application development is quick and easy with the included DB9 serial cable, sample software tools, and examples. A MON08 port is provided for development tool application support and is compatible with HC08 monitor interface cables and software. Debug monitor access is also supported through the DEBUG Port. A 28-pin MCU I/O connector (J1) allows interfacing the DEMO908LB8 board to an external development environment or external test equipment.

Features:

- 68HC908LB8 CPU
 - 20 PDIP, Sockets
 - 8K Byte Flash EEPROM
 - 128 Bytes Ram
 - 17 Shared General Purpose IO Lines, 1 Input only IO
 - 2-Ch Lamp Control Module
 - 2-Ch PWM
 - 7-Ch, 8-bit ATD
 - Op Amp / Comparator
 - 7 Key Board Wake-up Ports
 - 8Mhz Internal Bus Operation
 - Low Voltage RESET
- Regulated +5V power supply
- Power Input Selection Jumper
 - Power input from TB1
 - Optional power input from Connector J1
 - Optional power output through Connector J1
- 9.8304 MHz Clock Oscillator w/ Enable
- RS-232 Serial DEBUG Port w/ DB9 Connector for optional monitor access
- User Components Provided
 - 3 Push Switches; 2 User, RESET
 - 3 LED Indicators; 2 User, +5V
- Option Jumpers
 - Enable User Components
 - Power Select
 - OSC_EN
 - MON_EN
 - VTST_EN
 - OPAMP_EN
- Connectors
 - 28-pin MCU I/O Connector, stack through type
 - 2-Position, Screw-type, Power Input Terminal Block
 - MON08 Debug Cable Header
 - DB9 Serial DEBUG Connector
- Supplied with DB9 Serial Cable, Documentation (CD), and Manual.



Specifications:

Board Size 1.6" x 2.2"
 Power Input: +6V to +16V

REFERENCE

Reference documents are provided on the support CD in Acrobat Reader format.

DEMO908LB8_SCH_B.pdf	DEMO908LB8 Board Schematic Rev. B
DEMO908LB8_UG_A.pdf	DEMO908LB8 User Manual (this document)
DEMO908LB8_QSG.pdf	DEMO908LB8 Quick Start Guide
MC68HC908LB8.pdf	68HC908LB8 Device User Guide

See the HC08 Support CD provided with this board for all the documentation and support files provided.

OPERATING MODES

The DEMO908LB8 board operates in two basic modes Run Mode, or MON08 Debug Mode. Run Mode supports user application operation from Power-On or Reset. MON08 Debug Mode supports the development and debug of applications via the embedded debug monitor. See the related sections below for quickly starting the board in the desired operation mode.

The board has been preloaded with a demonstration program. The demo program operates in the Run Mode. The +5V LED will light when power is applied to the board. See the DEMO908LB8 Quick Start Guide provided with the demonstration board for details on running the demonstration program.

RUN Mode

Run mode allows user application to function when power is applied to the board. Use the following settings to configure the DEMO908LB8 board for RUN Mode to get started quickly.

1. Connect auxiliary equipment to board as required by application.
2. Configure the board option jumpers for run mode.

Table 1: Run Mode Setup

PWR_SEL	2 (pin3 – pin4)
OSC_EN	As needed
VTST_EN	OFF
MON_EN	OFF
USER	ALL ON – As needed
OPAMP_EN	OFF

3. Apply power to terminal block TB1. Limit power input between +6V and +20V.
4. The loaded application will begin to execute.

MON08 Mode

MON08 Debug Mode supports application development and debug using the internal HC08 monitor. MON08 mode is available to the user through an external MON08 debug cable connected to the 16-pin MON08 header. Alternately, a Serial MON08 interface is provided through the DEBUG 9-pin DSUB connector. The steps below describe using the external MON08 debug cable connected to the 16-pin MON08 header.

1. Connect auxiliary equipment to board as required by application.
2. Install and launch P&E PKG08Z tool set, CodeWarrior Development Studio, or other software capable of communicating with the HC08 MCU.
3. Configure the board option jumpers for MON08 mode.

Table 2: MON08 Mode Setup

PWR_SEL	2 (pin3 – pin4)	NOTE: The USER5 feature (POT) connects to a monitor mode configuration line. To ensure proper monitor mode entry, remove the USER5 jumper.
OSC_EN	ON	
VTST_EN	ON	
MON_EN	OFF	
USER	User5 OFF – others ON as needed	
OPAMP_EN	As Required	

NOTE: To enter Monitor Mode, voltage applied at TB1 must exceed +9V.

4. Connect power to terminal block TB1. Apply voltage between +9V and +20V.
5. Hosting development software will establish MON08 communication.

SOFTWARE DEVELOPMENT

Software development will require the use of an HC08 assembler or compiler and a host PC operating a MON08 debug interface. Supplied with this board is the CodeWarrior Development Studio for HC(S)08 along with the Axiom MON08 IDE for Windows for Debugging and Flash programming.

A powerful source code generation tool called DriveWay™ is also provided on the support CD. This can generate C source code for the HC08 microcontroller peripherals, based on setup. See the DriveWay™ readme.txt file for more information.

MEMORY MAP

Figure 1: Memory Map

0x0000 0x0058	IO Registers	59 bytes
	Unimplemented	
0x0080 0x00FF	RAM	128 bytes
	Unimplemented	
0x037E 0x061F	Flash Programming Routine ROM	674 bytes
	Unimplemented	
0xDE00 0xFDFF	Flash Memory	8192 bytes
0xFE00 0xFE0C	Status & Control	12 bytes
	Unimplemented	
0xFE20 0xFF7D	Monitor ROM	350 bytes
0xFF7E	Flash Block Protect	1 byte
	Unimplemented	
0xFFC0	Internal Osc Trim	1 byte
	Unimplemented	
0xFFDE 0xFFFF	Vectors	34 bytes

NOTE: Attempts to execute code from an unimplemented address range will cause an illegal address RESET

NOTE: \$FFF6 – \$FFFD used for 8 security bytes

DEVELOPMENT SUPPORT

Application development and debug for the target MC68HC908LB8 is supported through the MON08 debug interface. Monitor-mode access is available through the MON08 header and through the DEBUG connector. The VTST_EN option jumper is used to force monitor mode entry. This jumper must be installed as the MCU exits RESET to force monitor mode entry.

MON08 Header

A MON08 debug cable will attach to the 16-pin MON08 port. Several MON08 debug cables supply VTST directly, thereby, eliminating the need to set the VTST_EN option jumper. The MCU supports monitor mode communications at 9600 bps. Refer to MC68HC908LB8 documentation for further details.

Figure 2: MON08 Debug Port

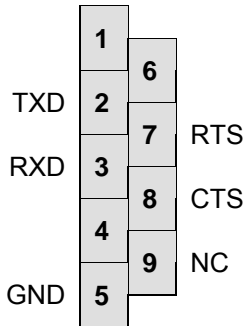
	1	2	GND
	3	4	PTA3/RST*
	5	6	PTA2/IRQ*
	7	8	PTA0
	9	10	PTA4
	11	12	PTA1
PTA5/OSC1	13	14	
V _{DD}	15	16	

See the HC08 Reference Manual for complete MON08 documentation

DEBUG Connector

Serial MON08 access is provided through a standard 9-pin DSUB connector. An RS-232 translator provides RS-232 logic level to TTL/CMOS logic level translation on the DEBUG port. The figure below shows the DB9 connector pin-out. The VTST_EN jumper must be installed as the MCU exits RESET to invoke monitor mode. The MON_EN option jumper enables serial MON08 access. The MCU supports monitor mode communications at 9600 bps. Refer to MC68HC908LB8 documentation for further details.

Figure 3: DEBUG Connector



Female DB9 connector that interfaces to the HC08 internal SCI1 serial port via the U2 RS232 transceiver. It provides simple 2 wire asynchronous serial communications without flow control.





Pins 1, 4, and 6 are connected together for NULL status to the host
 Pins 7, 8 are connected together for flow control if needed

MON08 Setup

The following figure shows the settings necessary to configure monitor mode operation. To ensure seamless monitor mode entry, the user should remove the USER5 jumper as shown below. The USER5 jumper enables the POT, which connects to monitor mode configuration line PTA1. Failure to remove this jumper may prevent monitor mode entry.

Configure MON_EN jumper for the monitor mode access desired.

Figure 4: MON08 Setup

MON_EN		ON/OFF	Enables MON08 communication through DEBUG connector. On for serial access via DEBUG connector off for MON08 cable access
VTST_EN		ON	Force MON08 Monitor Mode. Remove if using a powered MON08 debug cable.
OSC_EN		ON/OFF	Enable/Disable External Clock Oscillator if required
User-5		OFF	Disable User-5 Function. May not enter monitor mode if not removed.

NOTE: To enter the MON08 monitor mode, the input voltage must exceed +9V

NOTE: User-5 must be disabled to allow monitor mode entry

NOTE: Remove VTST_EN jumper if using a powered MON08 debug cable.

When using the MON08 cable to access monitor mode, the host software must be configured properly. Many MON08 cables are capable to powering the target board through the MON08 header. In this case, the appropriate voltages will be applied to the board and the state of the monitor configuration jumpers is DON'T CARE. If the board is not powered through the MON08 Port, then the minimum voltage applied to the board is +9V and the VTST_EN jumper must be installed. Regardless of how the board is powered, the state of the MON_EN jumper is DON'T CARE when using a MON08 cable.

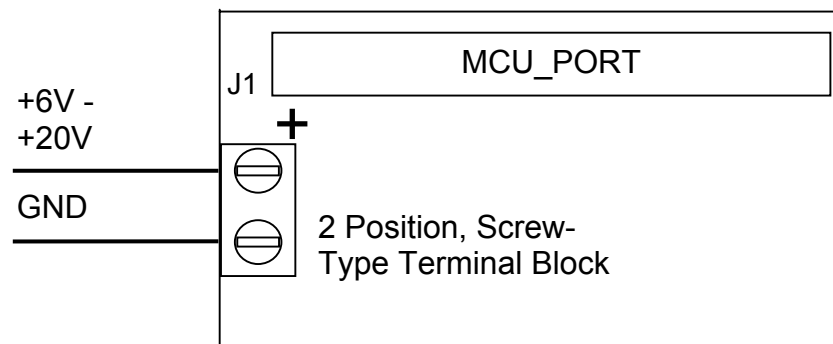
POWER

Input power may be applied by external connection to a 2 position terminal block or directly to connector J1. The PWR_SEL option header determines the selected power input.

Terminal Block

The TB1 terminal block allows external voltage to be supplied to the board. For normal operation, input voltage should be limited to the range of +6V and +20V. The terminal block is a 3.55mm, screw-type, connector that accepts a maximum 18 AWG wire. An on-board voltage regulator converts the input voltage to the +5V used by the board. Bulk capacitance on the regulator input and output provides noise immunity and reduces ripple.

A large plus sign (+) adjacent to the terminal block input indicates the positive terminal. Use care when connecting power to the terminal block. Reversing the power connections at TB1 may damage the board.

Figure 5: TB1 Terminal Block Connector

J1 Power Input

Positions J1-1 and J1-3 connect to the power rails on the board. The PWR_SEL jumper enables the connection between the +5V power rail and J1-1. This connection allows the board to either source power through connector J1 or supply power to external circuitry through connector J1.

Input voltage applied to the board at connector J1 must be regulated +5V, $\pm 5\%$. Exercise caution when using this feature. This input provides no over-current or over-voltage protection. The board may be damaged if over-driven.

When used to power external circuitry, connector J1 supplies voltage directly from the on-board voltage regulator. This output provides a regulated +5V, $\pm 5\%$ output to connector J1. The current limit of the regulator must be considered when using this feature.







PWR_SEL

Power routing on the DEMO908LB8 is determined by the PWR_SEL option header. The PWR_SEL header is also be used to configure the board to supply voltage to off-board circuitry. The figure below details the different configuration options available to the user.

CAUTION: Board damage may occur if the connector J1 power input pins (J1-1, J1-3) are over-driven.

The PWR_SEL option jumper supports 3 possible configurations; source power from TB1, source power from J1, or source power from TB1 and supply power to J1.

Figure 6: PWR_SEL Jumper Settings

- | | | |
|---|---|--|
| 1 |  | Board powered from external input connected to J1-1 (+) and |
| 2 |  | J1-3 (-). +5V Maximum input voltage. |
| | | |
| 1 |  | Board powered from external input connected to TB1 Terminal |
| 2 |  | Block. J1-1 is open or not connected. |
| | | |
| 1 |  | Board powered from external input connected to TB1 Terminal |
| 2 |  | Block. Board provides +5V output at pin J1 for use by external |
| | | circuits. |

NOTE: Power output from the board is limited by the 250 mA maximum output of the on-board voltage regulator.

NOTE: External circuit connected to J1 should limit current flow to less than 50 mA to prevent current-limiting the power supply (VR1).

RESET SWITCH

The RESET switch provides a method to apply an asynchronous RESET to the MCU and is connected directly to the RST* input pin. Pressing the switch asserts RESET forcing the MCU into a start-up condition. A pull-up bias resistor on the RST* input allows normal MCU operation. Shunt capacitance ensures an adequate input pulse width.

LOW VOLTAGE INHIBIT

The MC68HC908LB8 applies an internal Low Voltage Inhibit (LVI) protect against under-voltage conditions. The LVI is enabled out of RESET. Consult the MC68HC908LB8 reference manual for details on configuring LVI operation.



TIMING

The MCU provides an internal 16MHz timing source out of RESET. By default, the internal timing source exhibits a 25% tolerance. The OSCTRIM register allows trimming the internal timing source to $\pm 5\%$ of nominal. The default frequency supports an internal bus frequency of 4MHz. The user must configure the MCU to use the external clock input by writing the CONFIG2 configuration register. The MCU may be configured to output the internal oscillator frequency on the OSC2 pin. See MCU datasheet for configuration details.

A 9.8304 MHz clock oscillator at X1 provides alternate timing to the DEMO908LB8. The clock oscillator exhibits a 100-ppm frequency tolerance. The external clock oscillator produces a 2.46 MHz internal operating frequency. An option jumper at OSC_EN allows the user to enable or disable the external clock oscillator input.

Bus operating frequency is one-fourth (1/4) the selected timing source. The figure below shows the different option settings.

Figure 7: OSC_EN Option Header

-  **ON** Enables 9.8304 MHz Input to MCU on OSC1
-  **OFF** Disables 9.8304 MHz Input to MCU on OSC1

OPAMP_EN

The OPAMP_EN option header connects a photocell to the OP AMP/Comparator input on the MCU. This option header also enables the feedback loop on the op amp. The table below describes the setup for the OPAMP_EN option header. Refer to the MC68HC908LB8 manual for details on the operation of the OP AMP/Comparator. The table below shows the OPAMP_EN option header.

Table 3: OPAMP_EN Option settings

Jumper	ON	OFF	MCU PORT
OPAMP_EN-1	Enable RZ1	Disable RZ1	PTB5 (U1-11)
OPAMP_EN-2	Enable Feedback	Disable Feedback	PTB6 (U1012)

USER OPTIONS

The DEMO908LB8 provides 2 push-button switches, 2 LED indicators, a potentiometer, and a photocell circuit for use in application development. The photocell is connected to a gain stage amplifier internal to the MCU. The USER_EN option header allows each option to be enabled or disabled individually. To enable a user option, simply install the appropriate jumper. Remove the jumper to disable an option. The table below which jumper controls each user function. The table also shows the signal assigned to each user function.

NOTE: To enter monitor mode, jumper USER-5 must be removed. Otherwise, attempts to enter monitor mode will fail.

Table 4: USER_EN Option Settings

Jumper	On	Off	MCU PORT
User-1	Enable SW1	Disable SW1	PTB3 (U1-9)
User-2	Enable SW2	Disable SW2	PTB4 (U1-10)
User-3	Enable LED1	Disable LED1	PTA2 (U1-16)
User-4	Enable LED2	Disable LED2	PTA3 (U1-17)
User-5	Enable POT	Disable POT	PTA1 (U1-15)
OPAMP_EN - 1	Enable SENSOR	Disable SENSOR	PTB5 (U1-11)
OPAMP_EN - 2	Enable Feedback	Disable Feedback	PTB6 (U1-12)

NOTE: User-5 **must** be disabled when attempting monitor mode entry.

Pushbutton Switches

Two push button switches provide momentary, active low input for use in application development. Both switches are pulled-up external to the MCU. SW1 and SW2 are enabled to the HC08 I/O ports by the USER option bank. SW1 and SW2 provide input to HC08 I/O ports PTB3 and PTB4 respectively.

LED Indicators

Two LED indicators provide visual output indication for use in application development. Both LED's are active low and will light when a logic low (0V) is driven from the respective MCU port. Each LED is individually enabled by the USER option bank. MCU ports PTA2 and PTA3 drive LED1 and LED2 respectively.

RV1 Potentiometer

A 5k Ω , thumb-wheel potentiometer at RV1 provides variable resistance input for use in application development. The device provides a 0 to VDD (+5V typical) output to the PTA1 MCU input when enabled. The POT is enabled by the USER option bank. The POT is connected to the HC08 I/O port PT1.

RZ1 Photocell

A visible-light sensitive photocell (RZ1) is connected to the internal OP AMP/Comparator at PTB5. PTB7/V_{out} and PTB6/V₋ provide the feedback circuit used to control the OP AMP gain. Sensor output voltage ranges between .5V to VDD typical and is inversely proportional to incident light intensity (VDD = Dark).

I/O CONNECTOR J1

Connector J1 is a 28-pin, surface-mount, socket header mounted on the bottom of the board. The connector is mounted over plated-through holes in the PCB. This socket is a pass-through type socket designed to allow header insertion from either the top or bottom. This connector provides maximum flexibility allowing the board to connect directly to an expanded development environment or to test equipment. Access to all MCU signals is available at connector J1. The figure below details the pin-out for connector J1.

Figure 8: MCU IO Connector

V _x	1	2	PTC2/SHTDWN/IRQ*
GND	3	4	PTA5/RST*/BK15
PTA0/ADC0/KBI0	5	6	PTC0/OSC1
PTA1/ADC1/KBI1	7	8	PTC1/OSC2
PTA2/ADC2/KBI2	9	10	PB2/FAULT
PTA3/ADC3/KBI3	11	12	PTB5/V+
PTB3/PWM0	13	14	PTB56/V-
PTB4/PWM1	15	16	PTB7/VOUT/ADC6/FAULT
PTB0/TOP	17	18	PTA4/ADC4/KBI4
PTB1/BOT	19	20	PTA6/ADC5/TCH0/KBI6
	21	22	
	23	24	
	25	26	
	27	28	

NOTE: Power output from the board is limited by the 250 mA maximum output of the on-board voltage regulator.

APPENDIX A

BILL OF MATERIALS

Item	Qty	Title	Ref(m)	Mfr	Mfr-P/N
1	3	Cap, Tant, 10uF, 10V, SMB	C5, C13, C15	Avx	TAJB106K010R
2	5	Cap, Mon, 1uF, 16V, 0805	C8, C8, C9, C18, C20		
3	7	Cap, Mon, .1uF, 50V, 0805	C1, C2, C3, C10, C12, C14, C16	Meritek	MA080525U104M500
4	2	Cap, Mon, .01uF, 50V, 0805	C7, C19		
5	1	Cap, Cer, 39pF, 50V, 0805	C4	Yageo	0805CG390J9B200
6	2	Res, Carbon, 47K ohm, 5%, 0805	R1, R9		
7	4	Res, Carbon, 1K ohm, 5%, 1/16W, 0805	R2, R3, R7, R13		
8	4	Res, Carbon, 100Kohm, 5%, 1/16w, 0805	R4, R8, R10, R11		
9	3	Res, Carbon, 10K ohm, 5%, 0805	R5, R6, R14		
10	1	Res, Carbon, 100 ohms, 55, 1/16W, 0805	R12		
11	1	Ind, Ferrite, EMI, 330 ohm @ 100 MHz, 1.5A, 0805	FB1	Murata	BLM21P331SG
12	1	Clock Osc., 9.8304Mhz, SMT 5x7mm, 5V	X1	Epson	
13	1	Res, Variable, 5K ohm, 3/8 horz adj. W/ knob	RV1	Bourns	
14	1	Photocell, 30K -1M	RZ1	Photonic	PDV-P9003
15	1	Diode, Zener, 8.2V, 5%, 225mW, SOT23	D1	On Semiconductor	MMBZ5237BLT1
16	1	Diode, Schottky, 30V, 200mA, BAT54C, Com. Cathode, SOT23	D2	General Sem.	
17	3	LED, Green, w/reflector, 1206, SMT	LED1, LED2, +5V	Rohm	SML-010MTT86
18	1	VReg, LDO, 5V, 250mA, 8 SOIC	VR1	STMicroelectronics	L4931CD50
19	1	IC, MCU, MC68HC908LB8, 20 DIP	U1	Freescall	MC68HC908LB8CP
20	1	IC, Dual RS232 XCVR, 3.3V, ESD, 16SOIC	U3	Intersil	ICL3232ECBN
21	1	IC, Quad Buffer, 74ACT125, 14SOIC	U4		
22	3	Sw, PB, 5mm Sq, Thru	SW1, SW2, RESET	E-Switch	EG1827
23	1	Conn, 2x14 Socket Hdr, Pass Thru, .1", Bottom Entry, SMT	J1	Samtec	SSM-114-L-DV-K-BE-A
24	1	Conn, Term Blk, 2Pos, 3.55mm, thru	TB1	On Shore Technology	ED555/2DS
25	1	Conn, Dsub, 9P, F, RA, PCB Mount	DEBUG		
26	3	Conn, 1x2, Pin Header, .1" Ctr, Thru	VTST_EN, MON_EN, OSC_EN		
27	2	Conn, 2x2 Pin Header, .1" Ctr, Thru	PWR_SEL, OPAMP_EN		
28	1	Conn, 2x5 Pin Header, .1" Ctr, Thru	USER_EN		

29	1	Conn, 2x8 Pin Header, .1" Ctr, Thru	MON08		
30	1	Socket, IC, 20 DIP, MP	SU1		
31	12	Hdw, Shunt, 2 Pos, .1"		Generic	
32	2	Hdw, Stand-off, .250x.375, Hex, Alum		Keystone	2202
33	2	Hdw, Screw, 4-40x3/8, 18-8, SS			
34	1	PCB, DEMO908LB8, 2 layer, 1.6 x 2.2			