Dashboard Cluster Demo

Application Demonstration Board Supporting
Freescale Microcontrollers
- MPM5606S
- MC9S12HY64

Hardware User Guide

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REVISION

Date	Rev	Comments
June 19, 2009	A	Initial Release

CAUTIONARY NOTES

1) Electrostatic Discharge (ESD) prevention measures should be applied whenever handling this product. ESD damage is not a warranty repair item.

2) Axiom Manufacturing reserves the right to make changes without further notice to any products to improve reliability, function or design. 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 MPC5674FXMB board:

   a) This product as shipped from the factory with associated power supplies and cables, has been tested and meets with requirements of CE and 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 also cause interference with other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures should be taken.

TERMINOLOGY

This development board applies option selection jumpers. Terminology for application of the option jumpers is as follows:

Jumper on, in, or installed = jumper is a plastic shunt that fits across 2 pins and the shunt is installed so that the 2 pins are connected with the shunt.

Jumper off, out, or idle = jumper or shunt is installed so that only 1 pin holds the shunt, no 2 pins are connected, or jumper is removed. It is recommended that the jumpers be placed idle by installing on 1 pin so they will not be lost.

Cut-Trace – a circuit trace connection between component pads. The circuit trace may be cut using a knife to break the default connection. To reconnect the circuit, simply install a suitably sized 0-ohm resistor or attach a wire across the pads.

Signal names followed by an asterisk (*) denote active-low signals.

OVERVIEW

The Dashboard Cluster Demo board is a mock-up of an automotive instrument cluster designed to showcase the functionality and capabilities of the 32-bit MPC5606S Power PC processor and the 16-bit MC9S12HY64 microcontroller. While the board is designed to accept either the MPC or 9S12 controller, only 1 controller device may be installed.

The Dashboard allows the end-user to develop and debug application code for Motor Control, CAN, LIN, Sound, and instrumentation indicators. The Dashboard supports 3 different types of LCD displays. The MPC configuration ships with the Sharp LQ043T1DG01 LCD installed. Support for the Hitachi TX09D70VM1CDA LCD is also provided. The HY64 configuration ships with a chip-on-glass LCD from S-Tek Displays.

Board features connect to both the MPC5606S and the MC9S12HY64 unless noted otherwise.

NOTE:

The Dashboard Cluster Demo is available in either the MPC version, with the MPC5606S processor installed, or in the 9S12 version with the MC9S12HY64 microcontroller installed. Do not attempt to install both the MPC5606S and the MC9S12 simultaneously. Damage to 1 or both devices may occur.

GETTING STARTED

The MPC version the Dashboard ships with a pre-loaded application. This demonstration program exercises the stepper-motors, LCD panel, load-speaker, and LEDs. Each motor is moved to the “0” position then swept though its full range of motion. The LCD panel displays alternating color palettes of Red-Green-Blue. The loud-speaker emits a constant tone with volume controlled by the potentiometer at RV3. All LEDs are also turned ON. Simply connect power to the barrel connector, J11 and set SW3 to ON to execute the demonstration application.

The HY64 version of the Dashboard also ships with a pre-loaded application. To get started with the HY64 version, refer to the Quick Start Guide included with the board.

MPC5606S PROCESSOR

The MPC5606S family represents a new generation of 32-bit microcontrollers based on the Power Architecture. It belongs to an expanding family of automotive-focused products targeted to address the next wave of instrument cluster applications by addressing the significant growth in color Thin Film Transistor (TFT) displays within the vehicle. The product architecture is designed to fulfill the system requirements of selected implementations on a single-chip solution by driving the TFT display directly. The memory footprint can be further expanded via the on-chip QuadSPI serial flash controller module.

The Dashboard is designed to support both Cut-1 and Cut-2 versions of the MPC5606S processor. Cut-1 support is provided by board stack connectors at P1 and P2. These connectors are mounted on the back and are designed to interface to the MPC5606S 176QFP VALIDATION MINI-MODULE (Freescale pn MPC5606S_VAL_176SKT). The cut-2 MPC5606S is mounted directly to the Dashboard. Either version is directly capable of driving the LCD.

Refer to the MPC5606S Microcontroller Reference Manual for details on use and configuration of the MPC5606S device.

Development Support

The Dashboard applies both JTAG and NEXUS support for application development and debug when using the MPC5606S processor.

The JTAG controller provides the means to test chip functionality and connectivity while remaining transparent to system logic when not in test mode. Testing is performed via a boundary scan technique, as defined in the IEEE 1149.1-2001 standard. In addition, instructions can be executed that allow the Test Access Port (TAP) to be shared with other modules on the MCU. All data input to and output from the JTAGC is transferred in serial format

The Nexus Development Interface (NDI) block provides real-time development support capabilities for the MPC5604P MCU in compliance with the IEEE-ISTO 5001-2003 standard. This development support is supplied for MCUs without requiring external address and data pins for internal visibility.

Refer to the MPC5606S Reference Manual for details on use and capabilities of each development interface.

MC9S12HY64 MICROCONTROLLER

The MC9S12HY/HA family is an automotive, 16-bit microcontroller product line that is specifically designed for entry level instrument clusters. This family also services generic automotive applications requiring CAN, LCD, Motor driver control or LIN/J2602. Typical examples of these applications include instrument clusters for automobiles and 2 or 3 wheelers, HVAC displays, general purpose motor control and body controllers.

The MC9S12HY64 mounts directly to the Dashboard. Refer to the MC9S12HY/HA Reference Manual for details on use and configuration of the MC9S12HY64 device.

Development Support

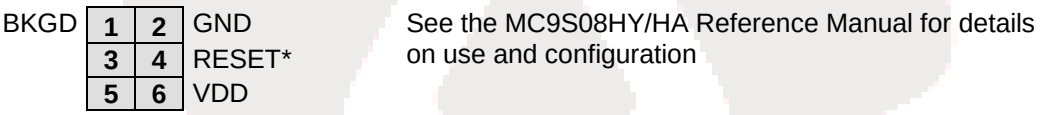
The MC9S12HY64 applies an internal S12SDBG module to provide an on-chip trace buffer with flexible triggering capability allowing non-intrusive debug of application software. The S12SDBG module is optimized for S12SCPU debugging.

Typically the S12SDBG module is used in conjunction with the S12SBDM module, whereby the user configures the S12SDBG module for a debugging session over the BDM interface. Once configured the S12SDBG module is armed and the device leaves background debug mode returning control to the user program, which is then monitored by the S12SDBG module.

BDM_PORT Header

A compatible HCS12 BDM cable may be attached to the 6-pin BDM interface header (BDM_PORT). Figure 1 below shows the pin-out for the BDM_PORT header.

Figure 1: BDM_PORT Header – J3



NOTE: The BDM_PORT header (J3) is installed only for HY64 configurations

POWER SUPPLY

Power to the Dashboard is applied through a 2.1mm, center-positive, barrel jack or a 3-position, 4.2mm pitch Molex, Mini-Fit connector. These inputs accept voltage inputs between +7.0V and 27V. An ON/OFF switch at SW3 allows the input voltage to be easily connected and disconnected. A resettable polyfuse at F1 provides protection from excessive current. A transient voltage suppression (TVS) device at D10 provides input protection from excessive voltage.

NOTE:

LIN functionality requires input voltage in excess of +12VDC.

Primary voltage to the Dashboard is provided by a fixed voltage output buck regulator at VR3. This regulator provides +5V, 1.5A output. The remaining voltage rails are derived from this voltage.

A fixed-output, low drop-out regulator at VR2 provides the +3.3V rail. This regulator can supply up to 800mA of current. Over-current and over-temperature protection ensure the device does not suffer damage in a fault condition.

The Sharp LCD used in the MPC5606S configuration requires +28V to drive the LED backlight. This voltage is provided by a boost regulator at VR1. A HV_EN option jumper allows this voltage rail to be disabled when not in use.

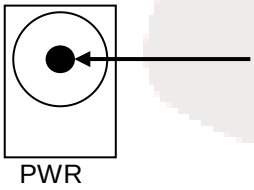
CAUTION:

On Revision A boards, the LCD, High Voltage is always enabled.

Power Input

Power input to the Dashboard consists of a 2.1mm, center-positive, barrel jack and a 3-position, 4.2mm Molex Mini-Fit connector. Input power should remain between +7VDC and +27VDC. Typical input voltage is +12VDC. Figure 2 below shows the barrel jack connection.

Figure 2: Barrel Connector – J11

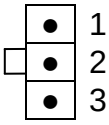


2.1mm, center-positive, +V input
Applied voltage: +7V to +27V, +12VDC Typical

NOTE: LIN functionality requires VIN ≥ +12V

Figure 3 shows the pin-out for the Molex Mini-Fit connector. The connector mates with housing 39-01-4030 and pin 39-00-027.

Figure 3: Alternate Power Input – J12



1	+Vin	Mates with:
2	GND	Housing – 39-01-4030
3	NC	Pins – 39-00-0217

Input Protection

Over-current protection is provided by a resettable polyfuse at F1. Input current is limited by this device to 1.1A. This device will reset after a delay if the over-current condition is removed. Refer to the part data sheet for further details.

Over-voltage protection is provided by a transient voltage suppressor (TVS) at D10. The TVS activates at approximately 27V to protect the input.

ON_OFF Switch

The ON_OFF toggle switch connects and disconnects primary power input to the Dashboard. With the switch in the ON position, all power indicators should light. Inspect input power connection and source, and fuse F1 if power indication does not occur.

Ignition Switch

The Ignition Switch at SW2 may be used to simulate ignition in an automotive setting. This input connects to both the MCP5606S and the MC9S12HY64 ADC input through a voltage divider. This allows the user application to detect a “turning the key” input event. The ignition divider is designed to accept voltage inputs up to 27VDC without violating voltage level input on either the MPC5606S or the MC9S12HY64.

STEPPER MOTORS

The Dashboard applies 4 stepper motors for use by either the MPC5606S or the MC9S12HY64. Each stepper motor is capable of 315^{o} rotation. In Full-Step mode, each motor rotates in 3/4^{o} step increments. In micro-step mode, each motor rotates in 1/12 ^{o} step increments.

Each stepper motor has a pointer needle installed to simulate use in an automotive instrument cluster. The Dashboard applies 2 long indicator needles and 2 short indicator needles. Each motor position is marked, in silkscreen, with a scale indicating 1 ^{o}, 5 ^{o}, and 10 ^{o} steps.

Refer to the VID23 manual for details on use and capabilities of these stepper motors. Refer to the Dashboard Schematic for details on electrical connections.

CAUTION:

Do not rotate pointers by hand. Damage to the motor may occur if excessive torque is applied to the motor shaft

Stepper Motor Connections

Each stepper motor may be controlled by either the MPC5606S or the MC9S12HY64. Electrical connections to each motor are similar. This allows similar waveforms to created similar movement on different motors. The controller must be configured for Full H-Bridge Mode to properly drive the motors. Figure 4 show the connections for each stepper motor.

Figure 4: Stepper Motor Connections

Dashboard Motor	Reference Designator	MPC5606S / MC9S2HY64 H-Bridge Motor Output
MPH	M1	M0C0 / M0C1
FUEL	M3	M1C0 / M1C1
TEMP	M4	M3C0 / M3C1
RPM	M2	M2C0 / M2C1

Refer to the VID23 manual for details on waveform timing requirements.

Pointer Illumination

Each stepper motor pointer may be illuminated under software control. A white LED built-in to the motor provides pointer illumination. Pointer illumination is controllable by either the MPC5606S or the MC9S12HY64. Figure 5 shows the pointer illumination control connections for each motor.

Figure 5: Pointer Illumination

Dashboard Motor	Reference Designator	Pointer Illumination Control	
		MPC5606S	MC9S2HY64
MPH	M1	PC12	PS4
FUEL	M3	PC14	PS6
TEMP	M4	PC15	PR3
RPM	M2	PC13	PS5

LCD DISPLAYS

The Dashboard is designed to accept 1 of 3 different LCDs; the Sharp LQ043T1DG01, the Hitachi TX09D70VM1CDA, or the S-Tek GD-5506P. Only 1 LCD panel may be installed for any given configuration. The MPC version ships with the Sharp LQ043T1DG01 installed. The HY64 version supports only the S-Tek display.

MPC5606S LCD Support

The MPC5606S version of the Dashboard is designed to accept either the Sharp LQ043T1DG01 color LCD or the Hitachi TX09D70VM1CDA color LCD. FPC cable connections are not installed for the Hitachi LCD panel.

Sharp LCD Panel

The Sharp LQ043T1DG01 LCD is a color, active-matrix, TFT panel in landscape orientation. The panel can display graphics and text in 480 pixels by 272 lines (480 x RGB x 272) resolution. The panel is capable of 16.7 million colors delivered through a 24-bit (8-bit x RGB) interface. Refer to the Sharp LQ043T1DG01 Product Specification for details on use and configuration of the LCD.

Backlight intensity for the Sharp LQ043T1DG01 LCD panel is provided by a potentiometer. RV2 allows the end-user to vary LCD panel output display for various ambient environments.

Hitachi LCD Panel

The Hitachi TX09D70VM1CDA LCD is a color, active-matrix, TFT panel in portrait orientation. The panel can display graphics and text in 240 pixels by 320 lines (240 x RGB x 320) resolution. The panel is capable of 262 thousand colors delivered through an 18-bit (6-bit x RGB) interface. Refer to the Hitachi TX09D70VM1CDA Product Specification for details on use and configuration of the LCD.

The MPC5606S integrates a Display Controller Unit (DCU) to directly drive the LCD color panels. The DCU module is a system master that fetches graphics stored in internal or external memory and displays them on a TFT LCD panel. A wide range of panel sizes is supported and the timing of the interface signals is highly configurable. Graphics are read directly from memory and then blended in real-time, which allows for dynamic content creation with minimal CPU intervention. Graphics may be encoded in a variety of formats to optimize memory usage. The DCU also has the capability of displaying real-time video from an external video source.

Refer to the MPC5606S Reference Manual for detail on use and configuration of the DCU.

MC9S12HY64 LCD Support

The S-Tek GD-5606S LCD is a custom, chip-on-glass LCD panel for use in automotive instrument panels. The panel consists of 160 elements addressable using 4 backplane signals and 40 frontplane signals. The panel is configured for 1/4 duty, 1/3 bias operation at 5.0V. The LCD is transflective, TN type, with a 6 o'clock viewing angle. Refer to the GD-5606P data sheet for connection and use details.

The MC9S12HY64 applies an integrated LCD controller to drive the LCD panel directly. Refer to the MC9S12HY64 Reference Manual for details on using and configuring the LCD controller.

CAN

Though not exclusively intended for automotive applications, the CAN protocol is designed to meet the specific requirements of a vehicle serial data bus: real-time processing, reliable operation in the EMI environment of a vehicle, cost-effectiveness, and required bandwidth. The Dashboard applies a CAN transceiver to support CAN signaling for both the MPC5606S and the MC9S12HY64.

The MPC5606S applies a FlexCAN module for the Power PC which fully implements the CAN protocol specification, Version 2.0B and supports both standard and extended message frames. A flexible number of Message Buffers (16, 32 or 64) is also supported. The Message Buffers are stored in an embedded RAM dedicated to the FlexCAN module. Please refer to the MPC5606S Reference Manual for the actual number of Message Buffers configured in the MCU.

The MC9S12HY64 applies the Freescale scalable controller area network protocol controller module. This module is a communication controller implementing the CAN 2.0A/B protocol as defined in the Bosch specification dated September 1991. For users to fully understand the MSCAN specification, it is recommended that the Bosch specification be read first to familiarize the reader with the terms and concepts contained within this document. Refer to the MC9S12HY64 Reference Manual for details on use and configuration of the HY64 CAN module.

CAN Port

The Dashboard applies the TJA1040T CAN transceiver to interface between the CAN protocol controller and the physical bus. This device is primarily intended for high speed applications, up to 1 Mbaud operation. The device provides differential transmit capability to the bus and differential receive capability to the CAN controller. A 4-pin MOLEX connector provides an interface to external CAN cabling. Figure 6 below shows the CAN connector pin-out.

Figure 6: CAN Port – J9

Pin	TJA1040 CAN Transceiver Signal
1	CANL
2	CANH
3	GND
4	NC

NOTE: CAN Port Connector – Molex 39-30-3045

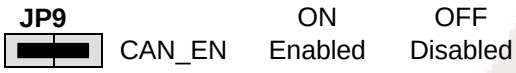
Mates with; Housing – Molex 39-01-4040, Pin – Molex 39-00-0036

The differential CAN signals are terminated by 120 ohms. This termination may be removed using the option jumpers at JP5. Avalanche diodes protect the CAN PHY from voltage transients on the differential signal lines.

CAN_EN Option Header

The CAN_EN option header enables or disables the CAN PHY. Enable CAN signaling by setting this option jumper to ON. The CAN PHY may be placed in low-power stand-by mode by setting this option jumper to OFF. Figure 7 below shows the CAN_EN pin-out.

Figure 7: CAN_EN Option Header – JP9



CAN Tx Enable – JP4

JP4 connects the target MCU signal, CNTX_B, input to the CAN transceiver. A cut-trace at this location provides default connection. A header pin is not installed at this location in default configurations.

LIN

The Local Interconnect Network (LIN) bus is a serial communications bus designed for automotive applications. The LIN specification is enforced by the LIN consortium and is currently at version 2.1. While similar to CAN, the LIN bus supports lower data rates and fewer nodes. Also, the LIN bus operates only in Master – Slave mode with a single Master and one or more Slaves.

The MPC5606S implements the LINFlex controller module. This LINFlex module supports versions 1.3, 2.0, and 2.1 and also provides SAE J2602 support in both Master and Slave mode. Refer to the MPC5606S Reference Manual for details on use and configuration of the LIN module.

The MC9S12HY64 provides basic support for the LIN protocol including break detect circuitry. The LIN module is implemented as part of the SCI module. Refer to the MC9S12HY64 Reference Manual for details on use and configuration of the LIN module.

LIN Port

The Dashboard applies a MC33661 LIN transceiver provides the physical layer interface (PHY) to the LIN bus. The PHY is configurable for Master or Slave mode operation under software (SW) or hardware (HW) control. The MC33661 is configurable for 10kbps, 20kbps, or 100kbps data rates. The Dashboard is designed to allow the board to power the LIN bus or

to be powered by the LIN bus. A 600W, 24V transient voltage suppressor (TVS) protects the PHY.

Refer to the MC33661 Reference Manual for detail on PHY functionality. The following sections detail functionality for LIN option jumpers. Refer to the MPC5606S or MC9s12HY64 Reference Manuals for details on configuring the selected MCU.

LIN Disable Option

LIN_DIS is routed to a test-point via located adjacent to the device. This input signal is pulled high by default to enable transceiver operation. Pull this input low to disable the LIN PHY

LIN Tx Enable – JP6

JP6 connects the target MCU signal, RXD_A, input to the LIN transceiver. A cut-trace at this location provides default connection. A header pin is not installed at this location in default configurations.

LIN Wake

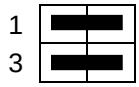
LIN wake is connected to the ignition switch, SW2, through a voltage divider. This allows the LIN bus to wake-up when the ignition switch is toggled.

LIN Power / Master Option Header – JP7

JP7 is a 2x2 option header allowing LIN bus configuration. Position 1 connects VIN from the input barrel connector to the LIN connector J10-3. This allows the Dashboard to source power to the LIN bus in Master mode or to sink power from the LIN bus in Slave mode.

JP7, position 3, allow for hardware selection of master mode. Set this option jumper ON to force Master mode when the LIN PHY exits reset or awakens from Standby mode. Figure 8 below shows the selections available using option jumper JP7.

Figure 8: LIN Power / Master Option Header – JP7



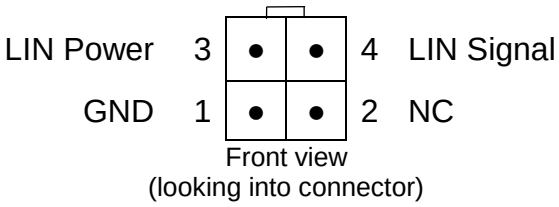
	ON	Off
LIN bus Power Selection	Enable	Disable
LIN bus Master Mode Selection	Enable	Disable

LIN Connector

The LIN connector at J10 connects the Dashboard to the LIN bus. This connector carries both signal and power connections. The connector is a Molex, Mini-Fit, 4-position connector with positive detent. Figure 9 below show the pin-out of the LIN connector as seen looking into the connector.

The LIN-J1 network connector provides a standard pin configuration with a network option position on pin 2.

Figure 9: LIN Connector – J11



NOTE: LIN Port Connector – Molex 39-29-1048

Mates with; Housing – Molex 39-01-2040, Pin – Molex 39-00-0036

DASHBOARD CLUSTER PERIPHERALS

In addition to the peripherals noted above, the Dashboard applies several additional peripherals to simulate an automotive instrument panel. A loud-speaker, with volume control, is applied for audible alerts. Various LEDs is applied to simulate instrument panel indicator lights. Three momentary push-button switches are applied for user input. A user potentiometer at RV1 provides user analog input.

Loud Speaker

A loud-speaker with amplifier allows user applications to generate sound effects from either the MPC5606S or the MC9S12HY64 target. The amplifier generated frequencies between 300Hz to 10 KHz. The SPKR_VOL potentiometer provides speaker volume adjustment. Figure 10 below shows the speaker connections to the MCP5606S and the MC9S12HY64

Figure 10: Speaker Control

MPC5606S	MC9S12HY64
SOUND	PWM3

LEDs

Several LED groups are applied to simulate indicator light output on an automotive instrument cluster. Various colors are used. Each LED group consists of 2 LEDs in series to provide substantial light output. While the MPC5606S target can drive all LED groups, the MC9S12HY64 has limited access to the LED groups. Figure 11 shows the LED control signal connections to the MPC5606S and the MC9S12HY64.

Figure 11: LED Connections

LED Group	MPC5606S	MC9S12HY64
LEFT	eMIOSA15	PR0/IOC0_6
RIGHT	eMIOSA14	PR1/IOC0_7
FUEL	eMIOSA20	NC
FOG	eMIOSA16	NC
TEMP	eMIOSA17	NC
ENGINE	eMIOSA18	NC
OIL	eMIOSA19	NC
HI	eMIOSA23	PR2/IOC1_6

Push-Button Switches

The Dashboard applies 3, momentary, push-button switches to support user input. Each push-button switch connects to GPIO pins on both the MPC5606S and the MC9S12HY64 targets. Each push-button is active-low with external pull-up resistor for proper operation

Figure 12: Push-Button Switch Connections

Push-Button Switch	Reference Designator	MPC5606S	MC9S12HY64
RIGHT	SW4	PF8	KWAD06
LEFT	SW5	PF9	KWAD07
MENU	SW6	PF1	KWAD05

Potentiometer

A 5k ohm, thumb-wheel type, potentiometer at RV1 provides variable resistance input for user applications. The output is the result of a voltage divider that changes as the thumb-wheel is turned. The potentiometer is connected between VDD and GND with the center tap providing the divider output. Figure 13 below details the user jumper settings and MCU connection.

Figure 13: User Potentiometer Connection

MPC5606S	MC9S12HY64
PC7/AN7	AN03