

RDAIRBAGPSI5 Airbag Reference Platform

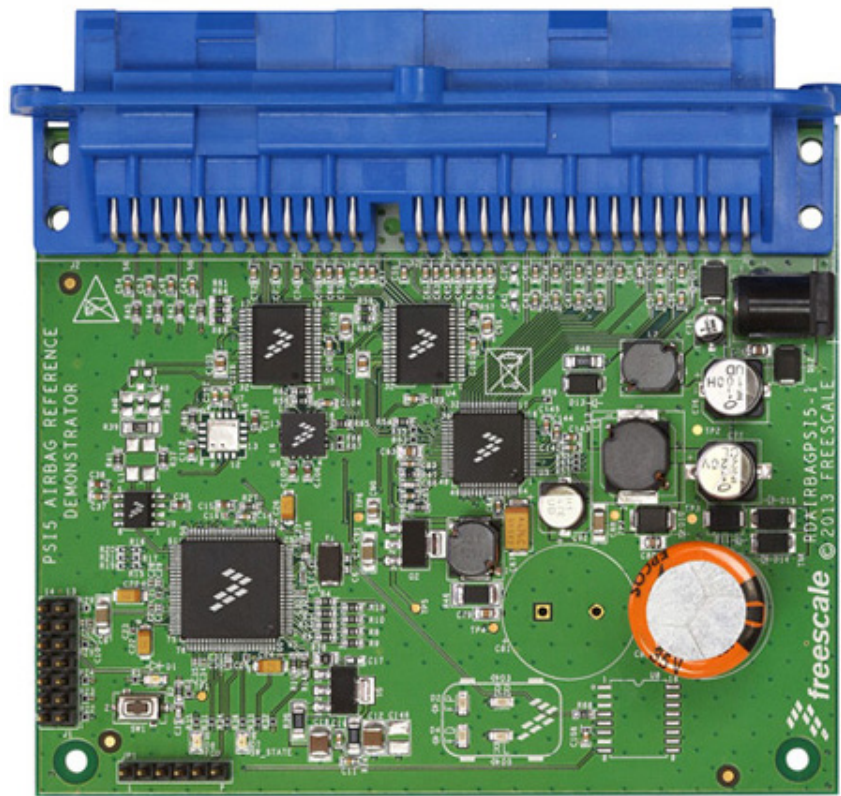


Figure 1. RDAIRBAGPSI5



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2 Getting Started

The RDAIRBAGPSI5 contents include:

- RDAIRBAGPSI5 Airbag Evaluation Platform board
- FTDI Cable
- Warranty card

The RDAIRBAGPSI5-1 contents include:

- RDAIRBAGPSI5-1 Airbag Evaluation Platform board
- PSI5 Satellites modules
- ECU Wiring Harness
- FTDI Cable
- Warranty card

2.1 Jump Start

Freescale's analog product development boards help to easily evaluate Freescale products. These tools support analog mixed signal and power solutions that include monolithic ICs using proven high-volume SMARTMOS mixed signal technology, and system-in-package devices utilizing power, SMARTMOS and MCU dies. Freescale products enable longer battery life, smaller form factor, component count reduction, ease of design, lower system cost and improved performance in powering state of the art systems.

- Go to www.freescale.com/analogtools
- Locate your kit
- Review your Tool Summary Page
- Look for



Jump Start Your Design

- Download documents, software, and other information

Once the files are downloaded, review the user guide in the bundle. The user guide includes setup instructions, BOM and schematics. Jump start bundles are available on each tool summary page with the most relevant and current information. The information includes everything needed for design.

2.2 Required Equipment

Minimum equipment required:

- Power supply (Power Plug or Laboratory Power Supply), with 12 V/2 Amp min current capability
- Oscilloscope (preferably 4-channel) with current probe(s)
- ECU Wiring Harness (included in the RDAIRBAGPSI5-1 kit)
- PSI5 Satellites Sensors (included in the RDAIRBAGPSI5-1 kit)
- Typical loads: 1.2 Ohm/2 Ohm for squibs, switch to ground for DC Sensors, LEDs for GPOs

Recommended equipment for ARP evaluation (GUI):

- FreeMASTER Software installed: <http://www.freescale.com/arp>
- Airbag Reference Platform FreeMASTER GUI Application: <http://www.freescale.com/arp>
- USB FTDI cable (Reference: TTL-232R-5V)

All software tools can be downloaded under Software & Tools tab of the [RDAIRBAGPSI5 webpage](#). Registration might be required in order to get access to the relevant files.

Recommended equipment for software development:

- Freescale CodeWarrior 10.5 or greater for Qorivva MCUs (Eclipse IDE) family installed: <http://www.freescale.com/arp>
- Airbag System Evaluation Software (source code): <http://www.freescale.com/arp>
- USB A-B cable
- P&E USB Multilink Debugger for Power Architecture:
http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=USBMLPPCNEXUS

2.3 System Requirements

- USB-enabled PC with Windows XP or greater
- FTDI Drivers installed for serial communication: <http://www.ftdichip.com/Drivers/VCP.htm>

3 Understanding the System

The Freescale Airbag Reference Platform (ARP) is an application demonstrator system which provides an airbag Electronic Control Unit (ECU) implementation example using complete Freescale standard products for the growing automotive safety segment. The GUI firmware does not constitute a true airbag application but is intended to demonstrate features and capabilities of Freescale's standard products aimed at the airbag market.

The ARP addresses a mid-range airbag market segment, with up to eight squib drivers (for squibs and seatbelt pre-tensioners) and four satellite sensor interfaces supporting four or more high g collision sensors positioned around the vehicle. All other vehicle infrastructure (including seat belt sensors and vehicle communications networks) and ECU functions (including full power supply architecture and a local mid g X/Y safing sensor) are also supported.

The new ARP hardware is implemented using a standard Freescale Qorivva 32-bit microcontroller (MPC560xP), Analog (MC33789 and MC33797). In the case of sensors, the families include both local ECU and PSI5 satellite sensors. The ARP implements a system safety architecture based on the features in the standard products supported by appropriate firmware.

The example ECU is implemented on a single Printed Circuit Board (PCB). Vehicle functions - in principal, satellite sensors, seat belt switches and warning lamps - can be accessed thanks to the ECU cables.

This User Manual is intended to detail the available hardware functionality and related software drivers (firmware) offered in the Freescale ARP.

The high level system block diagram here outlines the way the Freescale standard products are used to implement an example airbag ECU.

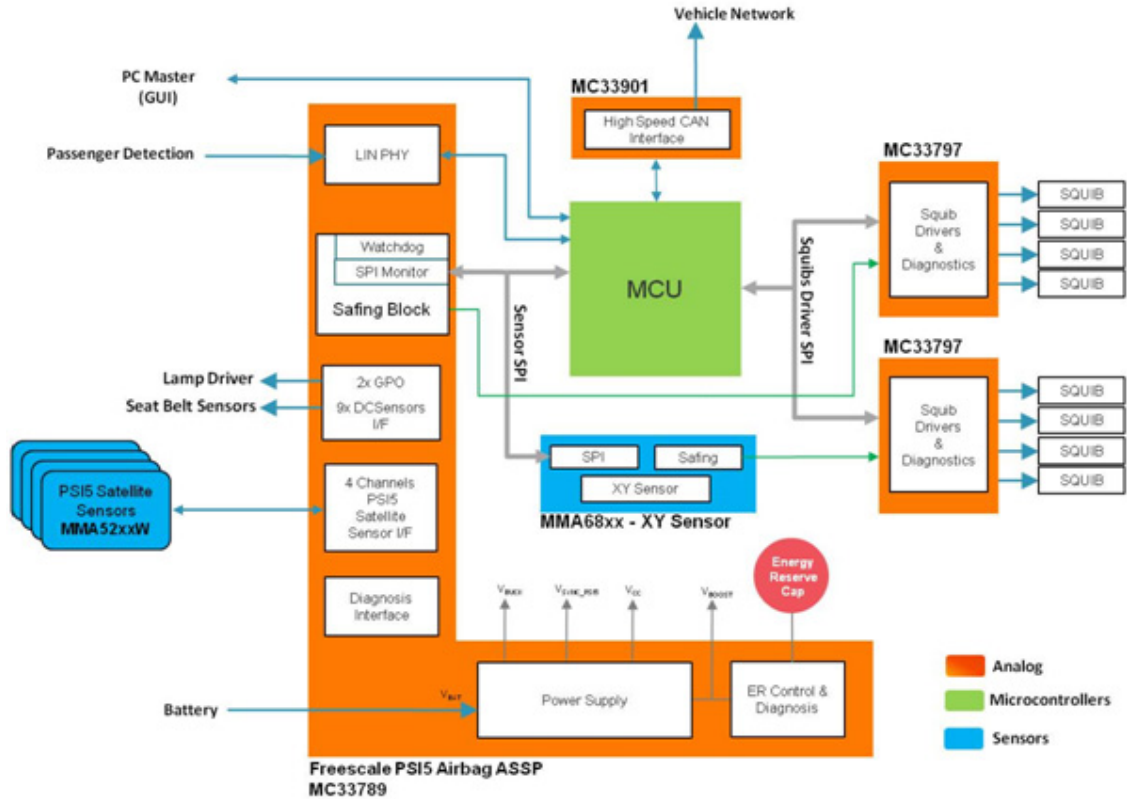


Figure 2. RDAIRBAGPSI5 Block Diagram

3.1 Device Features and Functional Description

This reference design features the following Freescale products:

Table 1. Airbag Reference Platform Device Features

Device	Description	Features
MPC560xP	Qorivva 32-bit Microcontroller	<ul style="list-style-type: none"> Scalable MCU family for safety applications e200z0 Power Architecture 32-bit core up to 64 MHz Scalable memory, up to 512 KB flash
MC33789	Airbag System Basis Chip (PSI5)	<ul style="list-style-type: none"> Power supply for complete ECU Up to four Satellite Sensor interfaces (PSI5) Up to nine configurable switch input monitors for simple switch, resistive and Hall-effect sensor interface Safing block and watchdog LIN 2.1 physical layer interface
MMA68xx	ECU Local X/Y Accelerometer	<ul style="list-style-type: none"> ± 20 g to ± 120 g full-scale range, independently specified for each axis SPI-compatible serial interface 10-bit digital signed or unsigned SPI data output Independent programmable arming functions for each axis 12 low-pass filter options, ranging from 50 Hz to 1000 Hz
MC33797	Four Channel Squib Driver	<ul style="list-style-type: none"> Four channel high-side and low-side 2.0 A FET switches Externally adjustable FET current limiting Adjustable current limit range: 0.8 to 2.0 A Diagnostics for high-side safing sensor status Resistance and voltage diagnostics for squibs 8-bit SPI for diagnostics and FET switch activation
MC33901	High Speed CAN Physical Layer	<ul style="list-style-type: none"> ISO11898-2 and -5 compatible Standby mode with remote CAN wake-up on some versions Very low current consumption in standby mode, typ. 8 μA Excellent EMC performance supports CAN FD up to 2 Mbps
MMA52xx MMA51xx	High G Collision Satellite Sensor	<ul style="list-style-type: none"> ± 60 g to ± 480 g full-scale range PSI5 Version 1.3 Compatible (PSI5-P10P-500/3L) Selectable 400 Hz, 3 pole, or 4 pole low-pass Filter X-axis (MMA52xx) and Z-axis (MMA51xx) available

3.1.1 MPC5602P - Microcontroller

This microcontroller is a member of the highly successful Qorivva MPC560xP family of automotive microcontrollers.

It belongs to an expanding range of automotive-focused products designed to address chassis applications as well as airbag applications. The advanced and cost-efficient host processor core of this automotive controller family complies with the Power Architecture® embedded category. It operates at speeds of up to 64 MHz and offers high performance processing optimized for low power consumption. It capitalizes on the available development infrastructure of current Power Architecture® devices and is supported with software drivers, operating systems and configuration code to assist with users implementations.

3.1.2 MC33789 - Airbag System Basis Chip

This device implements all vehicle sensor interfaces and the airbag system support functions:

3.1.2.1 Power Supply Block

- A switched-mode power supply DC-DC converter in a boost configuration to generate the high voltage level (33 V), in which energy is stored in the autarky capacitor, and used to allow continued operation of the airbag system for a defined time following a collision, which leads to disconnection of the battery
- A switched-mode power supply DC-DC converter in a buck configuration, to efficiently step down the boost supply to a level suitable for supplying the satellite sensors interfaces (9.0 V) and further regulators, for the local ECU supplies
- A switched capacitor charge pump to double the output of the buck converter, for use in supplying the necessary voltage for the PSI5 sync pulse generation (18 V)
- A linear regulator to provide the local logic supply (5.0 V) for ECU devices i.e. microcontroller, local sensor, squib driver

3.1.2.2 Safing Block

This block includes a SPI monitor which inputs all inertial sensors (PSI5 satellites and onboard sensors) read by the microcontroller over the sensor SPI interface, and compares it to pre-defined threshold acceleration values for each local and vehicle collision sensor. Based on this comparison, where the threshold is exceeded in three consecutive acquisition cycles, the system is armed by enabling the safing outputs, which in turn enables the squib drivers, so that the application can fire the necessary squibs based on the airbag algorithm results.

3.1.2.3 DC Sensors Interface

A low speed (DC) interface which connects to resistive, simple switch and hall effect sensors which are used to check whether seat belts are being worn through seat belt switches and seat position through seat track sensors.

3.1.2.4 PSI5 Satellite Sensors Interface

Four Satellite sensors interfaces, which connect to collision sensors distributed around the vehicle. The interfaces are implemented based on the PSI5 V1.3 specification, and can operate in synchronous modes. It detects current drawn by the satellite and translates the current-modulated satellite messages into digital data, which the MCU retrieves via the SPI interface.

3.1.2.5 LIN Physical Layer

For connection to vehicle diagnostic interface (K-line) or Occupant Classification System.

3.1.2.6 Lamp Driver

A flexible high or low-side driver which can be configured in hardware which supports PWM driven LED or warning lamp driver.

3.1.2.7 Diagnostics

A number of measures which allow diagnosis of implemented functions on the system basis chip, e.g. all voltage supplies including power transistor temperature monitors, autarky capacitor ESR, etc.

3.1.2.8 Additional Communication Line

MC33789 is designed to support the Additional Communication Line (ACL) aspect of the ISO-26021 standard, which requires an independent hardwired signal (ACL) to implement the scrapping feature.

3.2 MMA6813KW - ECU Local Sensor

The ECU local sensor acceleration data is used by the airbag application to cross check the acceleration data received from the satellite collision sensors, to confirm that a collision is really happening, and that airbags need to be deployed.

The local sensor used in the ARP is dual channel, and confirms both frontal and side impacts. In addition, the MMA68xx includes its own safing block, which will compare the measured acceleration to configurable thresholds and set safing outputs accordingly. This function is used in the ARP to enable the squib drivers, and therefore be an independent part of the system safing architecture - both the safing blocks in the system basis chip and in the local sensor must enable the squib drivers before the application is able to fire the appropriate squibs.

3.3 MC33797 - Four Channel Squib Driver

Each channel consists of a high-side and a low-side switch. The ARP uses two MC33797 devices connected in cross-coupled mode, i.e. high-side switch from one device and low-side switch from the other, connected to each squib or seat belt pre-tensioner. This ensures no single point of failure in the squib output stage.

The MC33797 implements a comprehensive set of diagnostic features that allows the application to ensure that the squib driver stage is operating correctly.

3.4 MMA5xxx - High G Satellite Collision Sensor

A single channel acceleration sensor operating in the range of 60 - 480g (depending on G-cell fitted), which includes a PSI5 V1.3 interface for direct connection to the system basis chip. The device can operate in either asynchronous (point-to-point single sensor connection) or synchronous (bus mode with multiple sensors connected to each interface) mode. The device can be used either for frontal collisions or side impacts. For more information about PSI5, please refer to the PSI5 standard specification for airbag systems: <http://psi5.org/>

4 Getting to know the Hardware

4.1 Overview

RDAIRBAGPSI5 is an eight loops airbag system ECU. **Figure 3** shows all the main components of an airbag ECU hardware. **Table 2** lists all the functions performed by each component.

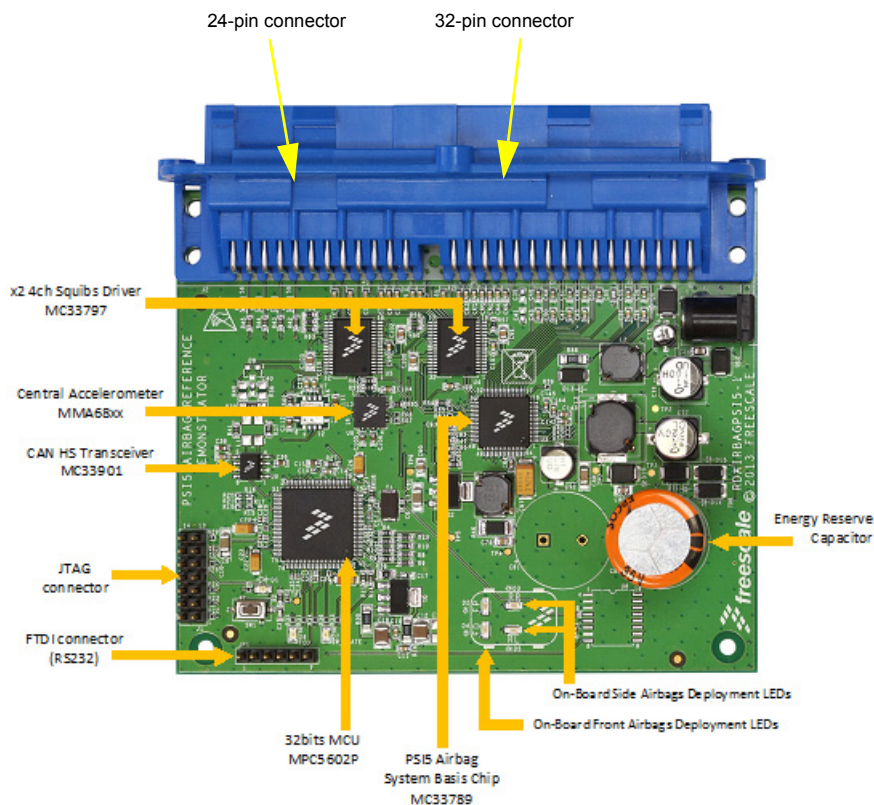


Figure 3. Board Description

Table 2. Board Description

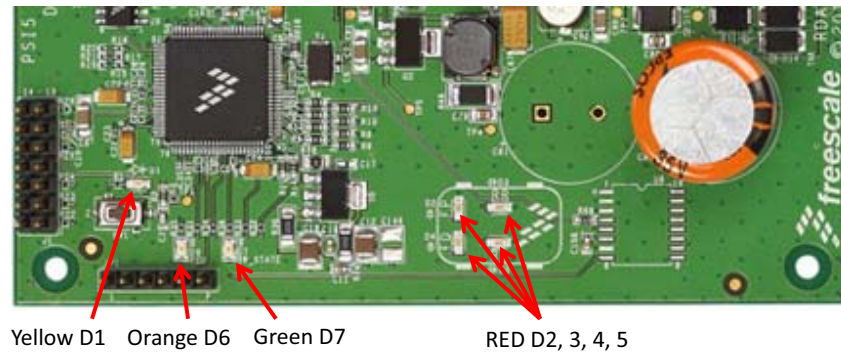
Name	Definition
x2 4ch Squibs Driver MC33797	x2 Four channels Squibs Driver configured in cross-coupled mode to make an eight firing loops airbag system
Central Accelerometer MMA68xx	Central Accelerometer, also called Local Safing Sensor, designed for use in automotive airbag systems
CAN HS Transceiver MC33901	Physical interface between the CAN protocol controller of an MCU and the physical dual wires of the CAN bus
JTAG Connector	P&E USB Multilink Debugger
FTDI Connector (RS232)	USB to serial communication connector for GUI application
32-bit MCU MPC5602P	Qorivva Power Architecture MCU for Chassis and Safety Application
PSI5 Airbag System Basis Chip MC33789	Airbag System Basis Chip (SBC) with Power Supply and PSI5 Sensor Interface
On-Board Front Airbags Deployment LEDs	2x LEDs used to indicate a front impact Deployment event: Front Driver and/or Front Passenger

Table 2. Board Description (continued)

Name	Definition
On-Board Side Airbags Deployment LEDs	2x LEDs used to indicate a side impact Deployment event: Rear Right and/or Rear Left
Energy Reserve Capacitor	Autarky Capacitor used as Energy Reserve in case of Battery disconnection

4.2 LED Display

This section describes the LEDs on the lower portion of the RDAIRBAGPSI5 board.


Figure 4. LED Locations

The following LEDs are provided as visual output devices for the RDAIRBAGPSI5 board:

1. LED D1 indicates when a System Reset occurred (LED color: Yellow).
2. LED D2 first indicates MC33789 is correctly initialized only during INIT phase. Then, it is used to display Front Passenger deployment during GUI Application mode (LED color: Red).
3. LED D3 first indicates MMA68xx is correctly initialized only during INIT phase. Then, it is used to display Rear Right Side deployment during GUI Application mode (LED color: Red).
4. LED D4 first indicates MC33797 are correctly initialized only during INIT phase. Then, it is used to display Front Driver deployment during GUI Application mode (LED color: Red).
5. LED D5 first indicates MCU is correctly initialized only during INIT phase. Then, it is used to display Rear Left Side deployment during GUI Application mode (LED color: Red).
6. LED D6 indicates when a FCU fault is detected by MCU (LED color: Orange).
Note: If no FCU faults are detected, LED is turned ON.
7. LED D7 indicates MCU Software is running (LED color: Green).

4.3 Connectors

This section discusses the ARP 32-pin and 24-pin positions and their descriptions.

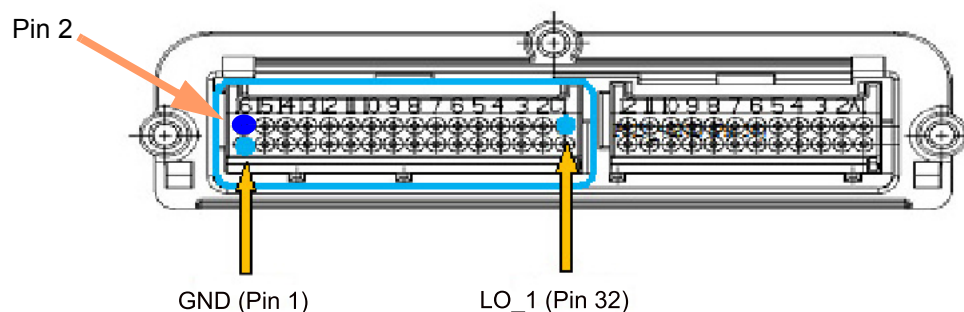
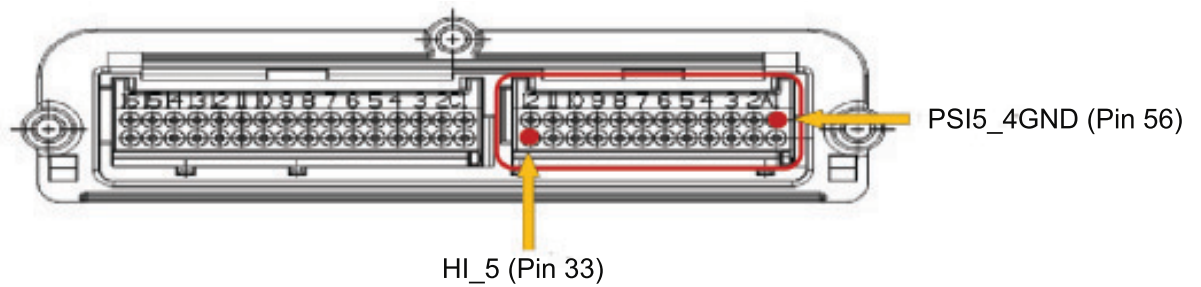


Figure 5. J1 32-pin Connector Location

Table 3: 32-pin Connector Pin List

Position	Signal name	Description	Position	Signal name	Description
1	GND	Ground Signal	17	IN6	Port 6 of input monitor for DC sensor
2	VBAT	Battery Voltage	18	IN5	Port 5 of input monitor for DC sensor
3	GND	Ground Signal	19	IN4	Port 4 of input monitor for DC sensor
4	VBAT	Battery Voltage	20	IN3	Port 3 of input monitor for DC sensor
5	NC	Not connected	21	IN2	Port 2 of input monitor for DC sensor
6	NC	Not connected	22	IN1	Port 1 of input monitor for DC sensor
7	OUT2_S	Source pin of configurable output FET 2	23	CANH	CAN Bus High Signal
8	OUT2_D	Drain pin of configurable output FET 2	24	CANL	CAN Bus Low Signal
9	OUT1_D	Drain pin of configurable output FET 1	25	HI_4	Source of the Squib Driver High-side switch 4
10	OUT1_S	Source pin of configurable output FET 1	26	LO_4	Drain of the Squib Driver Low-side switch 4
11	LIN_GND	LIN Ground	27	HI_3	Source of the Squib Driver High-side switch 3
12	LIN	LIN Signal	28	LO_3	Drain of the Squib Driver Low-side switch 3
13	NC	Not connected	29	HI_2	Source of the Squib Driver High-side switch 2
14	IN9	Port 9 of input monitor for DC sensor	30	LO_2	Drain of the Squib Driver Low-side switch 2
15	IN8	Port 8 of input monitor for DC sensor	31	HI_1	Source of the Squib Driver High-side switch 1
16	IN7	Port 7 of input monitor for DC sensor	32	LO_1	Drain of the Squib Driver Low-side switch 1


Figure 6. J2 24-pin Connector Location
Table 4: 24-pin Connector List

Position	Signal name	Description	Position	Signal name	Description
33	HI_5	Source of the Squib Driver High-side switch 5	45	NC	Not Connected
34	LO_5	Drain of the Squib Driver Low-side switch 5	46	NC	Not Connected
35	HI_6	Source of the Squib Driver High-side switch 6	47	NC	Not Connected
36	LO_6	Drain of the Squib Driver Low-side switch 6	48	NC	Not Connected
37	HI_7	Source of the Squib Driver High-side switch 7	49	PSI5_1OUT	PSI5 Channel1 Signal line
38	LO_7	Drain of the Squib Driver Low-side switch 7	50	PSI5_1GND	PSI5 Channel1 Ground line
39	HI_8	Source of the Squib Driver High-side switch 8	51	PSI5_2OUT	PSI5 Signal Channel2 line
40	LO_8	Drain of the Squib Driver Low-side switch 8	52	PSI5_2GND	PSI5 Channel2 Ground line
41	GND	Ground signal	53	PSI5_3OUT	PSI5 Channel3 Signal line
42	GND	Ground signal	54	PSI5_3GND	PSI5 Channel3 Ground line
43	NC	Not Connected	55	PSI5_4OUT	PSI5 Channel4 Signal line
44	NC	Not Connected	56	PSI5_4GND	PSI5 Channel4 Ground line

5 Describing the Device Functions

The RDAIRBAGPSI5UG Airbag Reference Platform is aimed to cover all major functions of a true airbag system application. The following section describes individual functions and available view using the GUI:

5.1 MC33789 - Airbag System Basis Chip

5.1.1 Power Supply - Boost Converter and Energy Reserve

Table 5. Power Supply - Boost Converter and Energy Reserve

Define	Function	Config Register	Diagnosis	Comment
MC33789	Energy Reserve Supply	PS_CONTROL	AI_CONTROL	

Default setting for the boost converter is ON and will start up when VBATT exceeds a predefined limit. Initially, the boost converter will charge a small capacitor. Default setting for the energy reserve is OFF to prevent excessive inrush current at key on. The firmware must turn the energy reserve on through the PS_CONTROL register once VBOOST is stable. Firmware can monitor VBOOST through the analog output pin selected through AI_CONTROL register. After the energy reserve is turned on, the large energy reserve capacitor (min 2200 μ F) will be charged.

5.1.2 Power Supply - Energy Reserve Capacitor ESR Diagnostic

Table 6. Power Supply - Energy Reserve Capacitor ESR Diagnostic

Define	Function	Config Register	Diagnosis	Comment
MC33789	Energy Reserve Capacitor Diagnostic	ESR_DIAG	ESR_DIAG	

During ESR diagnostic, the energy reserve capacitor is slightly discharged and the firmware can calculate, based on the discharge rate, the value of the capacitor's equivalent series resistance (ESR) - this is a measure of the condition of the capacitor.

5.1.3 Power Supply - Buck Converter

Table 7. Power Supply - Buck Converter

Define	Function	Config Register	Diagnosis	Comment
MC33789	Vcc5, DC Sensor and Satellite Sensor Supply	PS_CONTROL	AI_CONTROL	

Buck converter is internally enabled when the VBOOST voltage is above the under-voltage lockout threshold. The firmware cannot disable the Buck converter in the RDAIRBAGPSI5 application.

5.1.4 Power Supply - SYNC Pulse Supply

Table 8. Power Supply – SYNC Pulse Supply

Define	Function	Config Register	Diagnosis	Comment
MC33789	Satellite Sensor SYNC Pulse Supply	PS_CONTROL	AI_CONTROL	

Default setting for the SYNC supply is OFF. Firmware needs to turn the SYNC supply on through PS_CONTROL register only if the satellite sensors are operating in synchronous mode. Firmware can monitor VSYNC voltage through the analog output pin selected through the AI_CONTROL register.

5.1.5 Power Supply - ECU Logic Supply

Table 9. Power Supply - ECU Logic Supply

Define	Function	Config Register	Diagnosis	Comment
MC33789	Linear Regulator	–	–	

The internal ECU logic supply is always on and firmware has no configuration to perform.

5.1.6 Safing Block - Sensor Data Thresholds

Table 10. Safing Block - Sensor Data Thresholds

Define	Function	Config Register	Diagnosis	Comment
MC33789	Threshold	T_UNLOCK, SAFE_TH_n	–	

In order to be able to change the sensor data threshold value or values at which the ARM/DISARM pins are set to their active states (i.e. the system is armed when a sensor value exceeds the defined threshold), a secure firmware sequence must be carried out to unlock the threshold register using T_UNLOCK. Once that is done, the threshold can be changed by firmware through the SAFE_TH_n register.

Notes: There is no special firmware required to input sensor data into the safing block. The SPI protocol on the sensor SPI interface is the same to both the local sensor and the satellite sensor interfaces on the system basis chip, and whenever the microcontroller reads a sensor value, the response from the sensor or system basis chip is recognized as being sensor data, and is automatically read into the safing block. The only requirement the application has to meet is that the sensor data is read in the correct sequence, starting with the local sensor X-axis data followed by the Y-axis, and then the satellite sensor interfaces on the system basis chip.

5.1.7 Safing Block - Diagnostics

Table 11. Safing Block - Diagnostics

Define	Function	Config Register	Diagnosis	Comment
MC33789	Linear Regulator	–	SAFE_CTL	

The firmware has the capability to change the mode in which the safing block is operating, so that diagnosis of the ARM/DISARM pins can be diagnosed or the scrapping mode (i.e. the system is armed when no sensor data exceeds any threshold, used to fire all squibs when a vehicle is being scrapped) can be entered. Either of these changes is only possible at startup prior to the safing block entering normal operation.

5.1.8 DC Sensors

Table 12. DC Sensors

Define	Function	Config Register	Diagnosis	Comment
MC33789	Seat belt/Seat track sensor interface	DCS_CONTROL, AI_CONTROL	–	

The firmware must select which DC sensor is active and which supply voltage is used on that sensor through the DCS_CONTROL register. The firmware must also select the correct sensor to be read through the analog output pin using the AI_CONTROL register. Note that both registers can be returned to their default state by a correct write to the DIAG_CLR register.

5.1.9 PSI5 Satellite Sensor Interface

Table 13. PSI5 Satellite Sensor Interface

Define	Function	Config Register	Diagnosis	Comment
MC33789	Satellite Sensor	LINE_MODE, LINE_ENABLE	–	

The firmware must select the correct mode of operation of the satellite sensor interface and enable each interface individually. The interfaces should be enabled one at a time to reduce current inrush.

When the interface is enabled, the satellite sensor will automatically send its initialization data, and the firmware must handle this data to ensure the sensor is operating correctly.

5.1.9.1 LIN Physical Layer

Table 14. LIN Physical Layer

Define	Function	Config Register	Diagnosis	Comment
MC33789	LIN physical layer	LIN_CONFIG	–	

The firmware has the potential to change the configuration of the LIN physical layer, but the default setting is the most common configuration.

A special mode exists which allows the Manchester encoded data from a satellite sensor to be monitored on the LIN RXD output pin, for example in case MCU has a PSI5 peripheral module embedded.

5.1.9.2 Lamp Driver

Table 15. Lamp Driver

Define	Function	Config Register	Diagnosis	Comment
MC33789	Lamp driver	GPOn_CTL	GPOn_CTL	

The firmware must configure whether the driver is a high or low-side switch, and the PWM output duty cycle. In the response to the command, the firmware can check that high or low thresholds on the pins have been exceeded, and whether an over-temperature shutdown has occurred.

As part of the application, the warning lamp should be turned on at key on, kept illuminated until the startup diagnostic procedure has completed, and the system is ready to start operating.

5.1.9.3 Diagnostics

Table 16. Diagnostics

Define	Function	Config Register	Diagnosis	Comment
MC33789	Diagnostics	–	STATUS, AI_CONTROL	

The firmware can monitor the operation of the main ASSP through the STATUS and AI_CONTROL registers.

5.2 MMA6813KW - Local ECU Acceleration Sensor

The local ECU acceleration sensor is a dual channel device which also includes a safing block. At start up, the configuration, offset cancellation, and self test of the device, occur before the configuration is complete ('ENDINIT' set) and the device goes into normal operation.

5.2.1 Configuration - General

Table 17. Configuration - General

Define	Function	Config Register	Diagnosis	Comment
MMA6813KW	Configuration	DEVCFG	–	

The general configuration sets up the data format, whether offset monitoring is enabled, and the functionality of the ARM_X and ARM_Y output pins. When configuration is complete, the ENDINIT bit is set and this locks out access to the configuration registers.

5.2.2 Configuration - Axis Operation

Table 18. Configuration - Axis Operation

Define	Function	Config Register	Diagnosis	Comment
MMA6813KW	Configuration	DEVCFG_X, DEVCFG_Y	–	

The axis operation configuration triggers self-test and selects one of the low pass filter options for each axis.

5.2.3 Configuration - Arming Operation

Table 19. Configuration - Arming Operation

Define	Function	Config Register	Diagnosis	Comment
MMA6813KW	Configuration	ARMCFG_X, ARMCFG_Y	–	

The arming operation configuration defines the arming pulse stretch period and the arming window, which has different meanings, depending on which arming mode is configured.

5.2.4 Configuration - Arming Threshold

Table 20. Configuration - Arming Threshold

Define	Function	Config Register	Diagnosis	Comment
MMA6813KW	Configuration	ARMT_XP, ARMT_XN ARMT_YP, ARMT_YN	–	

For each axis, both the positive and negative threshold can be set above which and when the arming window requirements are met, the arm outputs will be set to active as defined in the arming operations register.

In the startup phase, the threshold can be set to such a level that when the self test deflection is triggered, the arming outputs will become active. This can be used as part of the self-test at startup. After completion of the self test, thresholds should be set back to the correct application values, and before the configuration is complete, by setting the 'ENDINIT' bit, after which no further configuration changes can be made.

The complete startup and self-test procedure is described in the ARP specification (Airbag Reference Platform).

Note that after the configuration is complete and the 'ENDINIT' bit is set, a CRC check of the configuration is carried out in the background, which will lead to an error in the status register if a configuration bit flips.

5.2.5 Status

Table 21. Status

Define	Function	Config Register	Diagnosis	Comment
MMA6813KW	Status	–	DEVSTAT	

Internal errors are flagged in the DEVSTAT register.

5.3 MC33797 - Four Channel Squib Driver (FCS)

The ARP uses two Four Channel Squib Drivers (FCS) configured in cross-coupled mode to safely implement eight squib drivers.

The four channel squib driver is addressed using an 8-bit SPI interface over which commands and data are sent.

The only configuration possible is the time the device remains enabled after the fire enable (FEN1, FEN2) pins have been activated. This is equivalent to the arming pulse stretch time applied to the safing output on both the system basis chip and the local ECU sensor. Two commands are required to change this time - first is an unlock command and second is the programmed time between 0 and 255 ms. Default is 0 ms.

Firing the squibs also requires two commands - the first arms one of the banks of drivers, the second turns on the required switches. More than one switch can be turned on by a single command.

The majority of the commands relate to diagnostics of the four channel squib driver and the connected squibs. A full list of diagnostic commands is available in the ARP specification (Airbag Reference Platform).

5.4 MMA5xxx High G Satellite Collision PSI5 Sensor

Configuration of the device is done off line prior to assembly in the system.

As soon as the device is switched on, it will begin an internal configuration and self test, and also sends initialization data, which is received in the system basis chip and checked by the application. Once the device has completed sending the initialization data, which concludes with an OK or NOK message, it enters normal operation and starts sending sensor data, either autonomously if in asynchronous mode, or in response to SYNC pulses on the satellite sensor interface if in synchronous mode.

6 Installing the Software and Setting up the Hardware

ARP software is built on basic low level MCU drivers (MCAL), which provide access to the modules ADC, GPIO, EEPROM, SPI, LINFlex, etc. in the microcontroller, thus providing all necessary MCU functions. The upper software layer contains Complex Drivers for all main ARP devices - Main Airbag ASIC MC33789 (Analog system Basis Chip (ASBC) Driver), Central Accelerometer MMA6813KW (ACC Driver), and Four Channel Squib Driver MC33797 (SQUIB Driver). These drivers have an MCU independent API, which means no modification of ASBC, SQUIB or ACC drivers is needed for all MCU derivatives (8/16/32-bit).

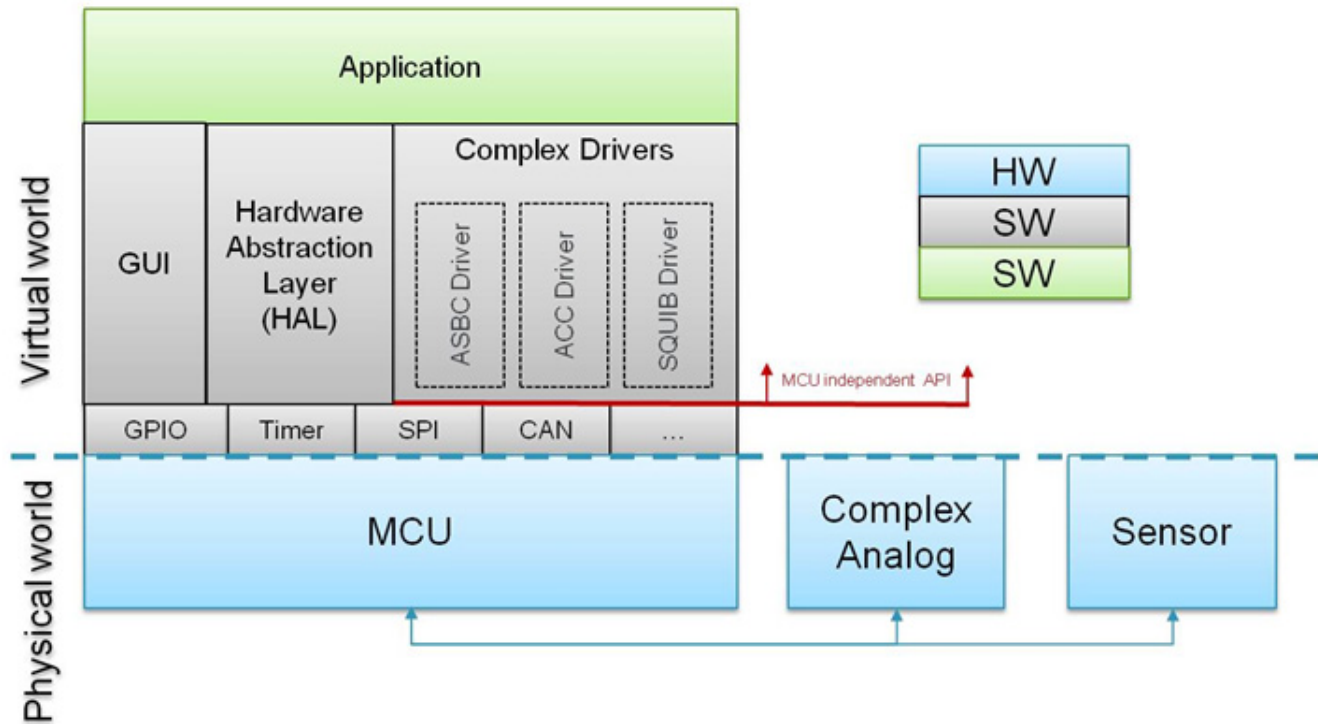


Figure 7. SW Design Concept

6.1 Hardware Abstraction Layer (HAL)

The software architecture for this Airbag Reference Platform uses a Hardware Abstraction Layer that removes details of working with a MPC560xP 32-bit microcontroller. This will allow a developer to focus attention on the application tasks instead of focusing on the very specific functionality of the MCU used. Software applications can then be created based on a higher level of understanding.

6.2 GUI - FreeMASTER Software

FreeMASTER software was designed to provide a debugging, diagnostic, and demonstration tool for the development of algorithms and applications. Moreover, it's very useful for tuning the application for different power stages and motors, because almost all the application parameters can be changed via the FreeMASTER interface. This consists of a component running on a PC and another part of the component running on the target controller, connected via an RS-232 serial port or USB. A small program is resident in the controller that communicates with the FreeMASTER software to parse commands, return status information to the PC, and process control information from the PC. FreeMASTER software, executed on the PC, uses Microsoft Internet Explorer as the user interface.

6.2.1 Installing FreeMASTER on your Computer

To set up the GUI on your PC, you have to install the FreeMASTER software if not already installed.

Notes: If FreeMASTER is already on your system, the steps in this section can be skipped.

1. Start the FMASTERSW.exe install shield wizard. The file can be downloaded from <http://www.freescale.com>. The License Agreement box is displayed and you are prompted for further actions.
2. Clicking the Next button starts the installation program. The Installation Wizard prompts you for further actions.
3. Follow the instructions given by the Installation Wizard.

6.2.2 FreeMASTER Serial Communication Driver

The presented application includes the FreeMASTER Serial Communication Driver.

The main advantage of this driver is a unification across all supported Freescale processor products, as well as several new features that were added. One of the key features implemented in the new driver is Target-Side Addressing (TSA), which enables an embedded application to describe the memory objects it grants the host access to. By enabling the so-called "TSA-Safety" option, the application memory can be protected from illegal or invalid memory accesses.

To include the FreeMASTER Serial Communication Driver in the application, the user has to manually include the driver files in the CodeWarrior project. For the presented application, the driver files have already been included.

The FreeMASTER driver files are located in the following folder:

- {Project_Loc}\Sources\GUI

This folder contains platform-dependent driver C-source and header files, including a master header file freemaster.h.

For instance, in the current ARP, user will find freemaster_MPC56xx.c and freemaster_MPC56xx.h for Qorivva MPC56xxP family.

This folder also contains common driver source files, shared by the driver for all supported platforms.

All C files included in the FreeMASTER folder are added to the project for compilation and linking.

The master header file freemaster.h declares the common data types, macros, and prototypes of the FreeMASTER driver API functions. This should be included in the application (using #include directive), wherever there is need to call any of the FreeMASTER driver API functions.

The FreeMASTER driver does NOT perform any initialization or configuration of the SCI module it uses to communicate. This is the user's responsibility to configure the communication module before the FreeMASTER driver is initialized by the FMSTR_Init() call. The default baud rate of the SCI communication is set to 9600 Bd.

FreeMASTER uses a poll-driven communication mode. It does not require the setting of interrupts for SCI. Both communication and protocol decoding are handled in the application background loop. The polling-mode requires a periodic call of the FMSTR_Poll() function in the application main.

The driver is configured using the freemaster_cfg.h header file. The user has to modify this file to configure the FreeMASTER driver. The FreeMASTER driver C-source files include the configuration file, and use the macros defined there for conditional and parameter compilation.

For more information, a detailed description of the FreeMASTER Serial Communication Driver is provided in the FreeMASTER Serial Communication Driver User's Manual.

6.2.3 Airbag Reference Platform - GUI

FreeMASTER GUI application can work in two modes:

- Debug mode - GUI firmware together with GUI applications allow debug of the main ARP devices - MC33789 (Airbag System Basis Chip), MC33797 (Four Channel Squib Driver), and MMA6813KW (Central Accelerometer). The device registers are readable and configurable. At all times, the registers remain visible and can be monitored. This is intended to aid engineers understand both the hardware and software routines.
- Application mode - Application mode allows ARP users to view acceleration data from central and satellite accelerometers. These numerical values are also plotted on a graph, which allows informative outlook to the acceleration levels of all sensors. Deployment of squibs is simulated in this mode on a simple car model picture, using pictures of both front and side deployments. The same simulation is performed at MCU level, indicated using the four onboard red LEDs.

Notes: The GUI firmware is already loaded into Airbag Reference Platform after delivery and immediately ready for using with the FreeMASTER GUI application.

6.2.4 FreeMASTER Debug Mode

Parameters of the devices MC33789, MC33797, or MMA6813KW, can be arbitrarily changed. Parameters are sent to the selected device after the button press "Send Parameters To Reference Board". All meaningful device registers are shown in the registry table "Command Responses Table" at the bottom of the each device page. For each cell in this table, a tool-tip help is available. View these tips, hover over the cell to see descriptions of the selected register (For an example page see [Figure 8](#)).



Figure 8. FreeMASTER Debug Page for the MC33789 Device

After starting the watchdog refresh (Watchdog -> Enable), parameters "Safing Thresholds" and "Dwell Extensions" in MC33789 cannot be changed.

6.2.5 FreeMASTER Application Mode

ARP Application mode permits the user to (see [Figure 9](#)):

- View acceleration data from central and satellite accelerometers. These numerical values are displayed in points where sensors should be placed inside the car.
- View acceleration data plotted on a graph, which allows informative outlook to the acceleration levels of all sensors and a simple car model simulation of the both front and side collisions. Plotted data is only informative, since transferred data from sensors is averaged for illustration of ARP functionality only.
- Simulate deployment of an airbag when the acceleration data reaches the threshold values. These thresholds are set to very low limits, so even a soft hit of the satellite sensor to the ARP board will cause relevant airbags' "deployment". Airbags deployment is illustrated in the GUI thanks to front and side airbags pictures. (Any "collision" at the driver or passenger location causes inflation of two front airbags. Impact from left side causes inflation of the left side airbags, and impact from right side causes deployment of the right side airbags. Anytime after deployment, simulation is possible to reset an inflated bag or bags by pressing button "Reset Deployed Airbags".



Figure 9. FreeMASTER Application Mode

Notes: In this GUI mode during simulated airbags' "deployment", the relevant squibs drivers are not activated. In order to deploy front airbags, a combination of acceleration values (Front Satellites & Central Accel) above the threshold is required to simulate front deployment.

Other deployment indicators can be found on the actual ARP Hardware. Four red color LEDs are implemented onboard in order to provide the same information as displayed on FreeMASTER GUI. User can also take advantage of this onboard LEDs in case a real application firmware is developed based on Freescale ARP to indicate which car airbags have been deployed.

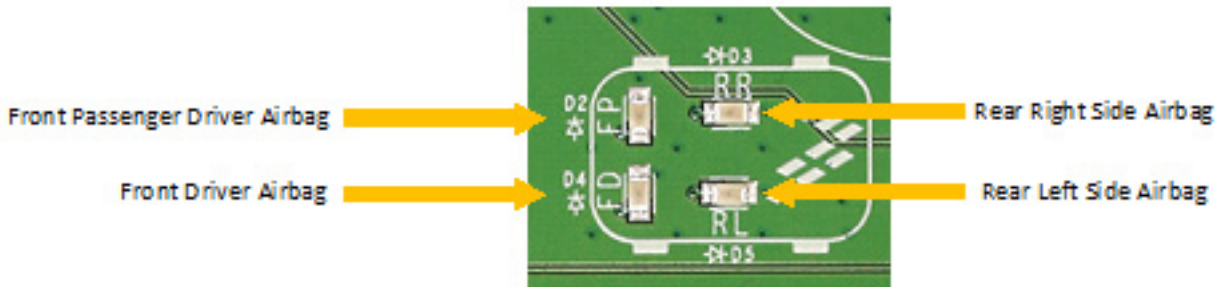


Figure 10. On-Board and Side Airbags Red Color LEDs

6.2.6 Configuring the Hardware using FreeMASTER

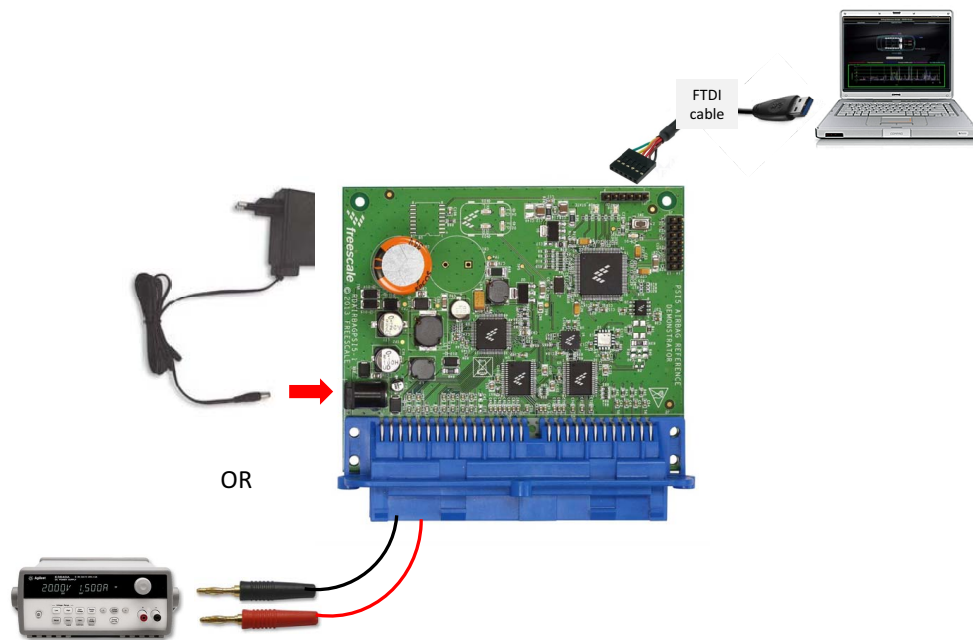


Figure 11. RDAIRBAGPSI5 Configured for ARP Evaluation Using FreeMASTER GUI

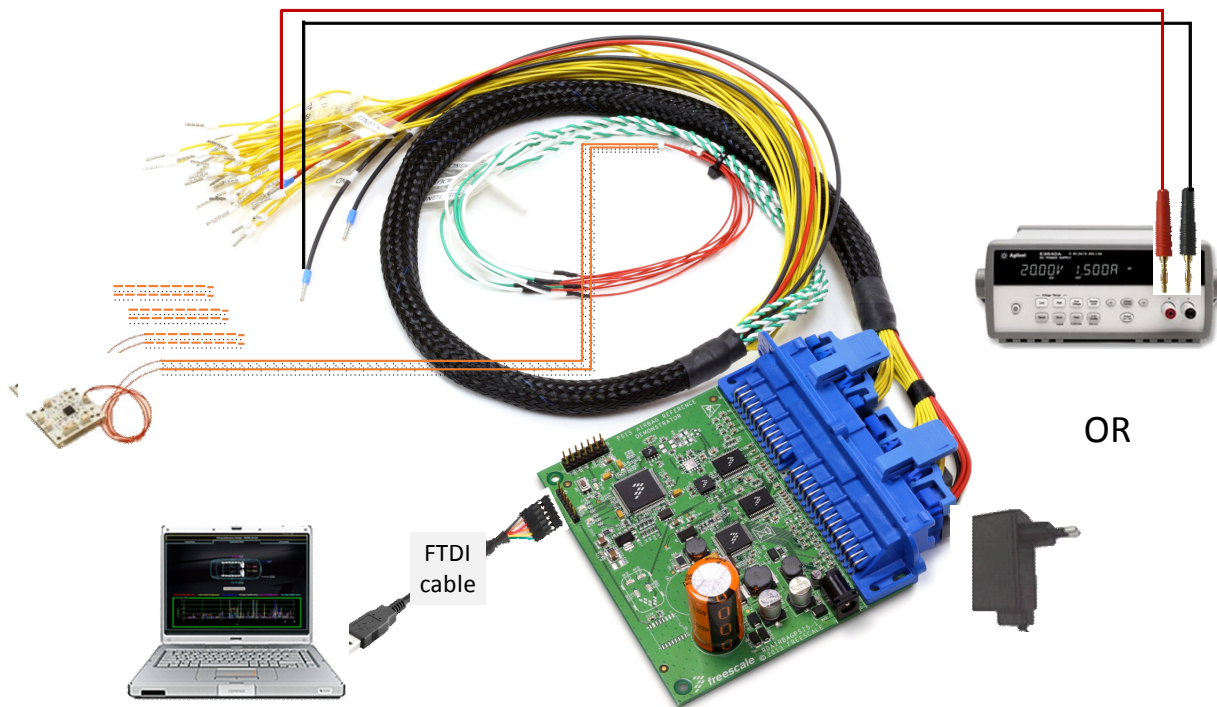


Figure 12. RDAIRBAGPSI5-1 Configured for ARP Evaluation Using FreeMASTER GUI

In order to perform the demonstration examples, set up the reference platform hardware and software as follows. All software tools can be downloaded under Software & Tools tab of the [RDAIRBAGPSI5 webpage](#). Registration might be required in order to get access to the relevant files.

1. Install FreeMASTER Software (can be downloaded from freescale.com/freemaster).
2. Connect ECU wiring harness to the ARP blue connector.
3. Connect the power supply, either using a power plug or lab power supply.

CAUTION

Please pay attention to the power supply's polarity.
(DO NOT connect both power supply's inputs).

4. Switch on the power supply at 5.2 - 20 V. (Nominal value: 12 V)
5. Initialization Phase:
 - On the ARP Hardware, four red LEDs should turn on one after another, then they all turn off
 - This firmware sequence is intended to provide visual information to the user that all four main devices (MC33789, MMA68xx, MC33797 and MCU) are correctly initialized
 - The Green and Orange LEDs should remain ON
6. Connect the Airbag Reference Platform to the PC using an FTDI cable. Upon connection of FTDI cable, autoinstallation begins. If not, visit <http://www.ftdichip.com/Drivers/VCP.htm> and select the driver compatible with the OS being used.
7. Wait until FTDI drivers installation is completed (during first connection, drivers for the device have to be installed. This can take several minutes). When finished, a status message is displayed in the Windows taskbar and confirms the appropriate drivers were installed correctly.
8. Launch the ARP Graphical User Interface by double clicking on the RDAIRBAGPSI5_FreeMASTER application file. The ARP GUI should appear as in [Figure 13](#).

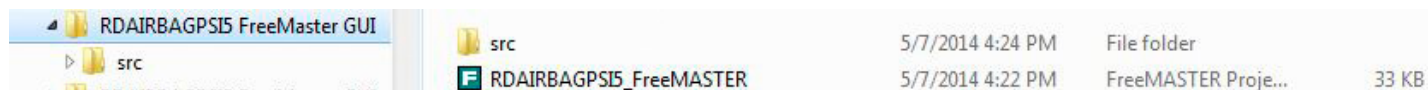


Figure 13. ARP Graphical User Interface

9. Open "File/Start communication" to establish the connection. See [Figure 14](#).

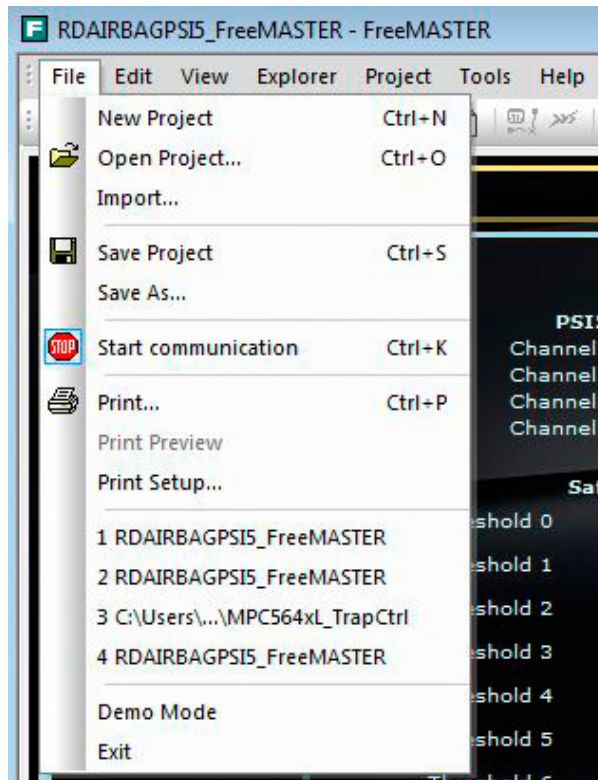


Figure 14. ARP Graphical User Interface File/Start

At the bottom of the GUI screen, a message "Communication With Reference Board Works Properly" should appear. Once the steps above are all accomplished, proceed to using the GUI for evaluation. Refer to the [Troubleshooting Section](#) for assistance in using the GUI.

6.2.7 Troubleshooting

If this message box appears immediately after launching the ARP GUI, select OK and proceed to the following steps:

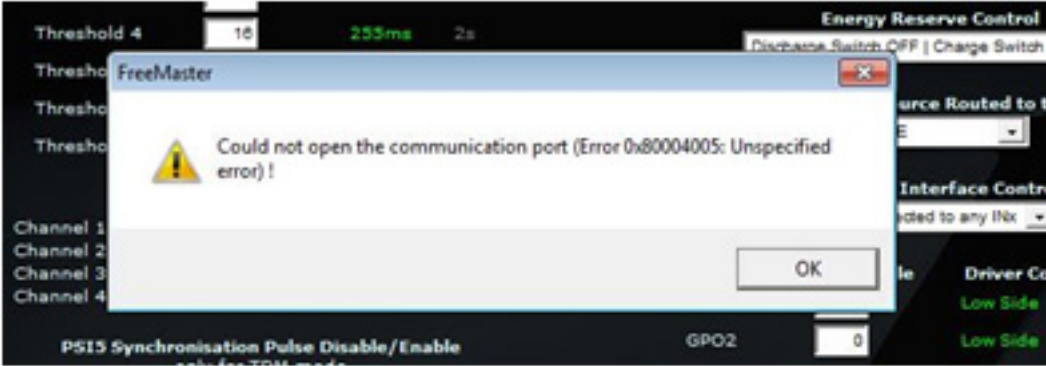


Figure 15. Unspecified Error Window

1. In Project menu, under Options -> Comm tab, select correct COM port associated with the FTDI cable now connected to the host computer. Speed used for this GUI is 256000.
2. Open "File\Start communication" to establish the connection.

Incomplete and/or inaccurate execution of the above steps results in the message depicted in **Figure 15**.

The error sources could be:

- The ARP demo has no power. Check the power supply setup.
- COM ports are not assigned correctly.
- On the PC desktop, right click on "My computer" and select "Properties". The "System Properties" window will open.
- Select the "Hardware" tab, then select the "Device Manager" button. In a new window, expand the "Ports (COM & LPT)".
- If the USB drivers are installed properly, the virtual COM ports will be listed, e.g. "USB Serial Port (COMx)". The PC assigns COMx port number. Note the port number used for FreeMASTER control pages configuration described in **Step 1** above.

COM ports are now assigned correctly, and the previous message box no longer appears. Instead, at the bottom of the GUI, a message "Communication With Reference Board Works Properly" is seen. See **Figure 16**.

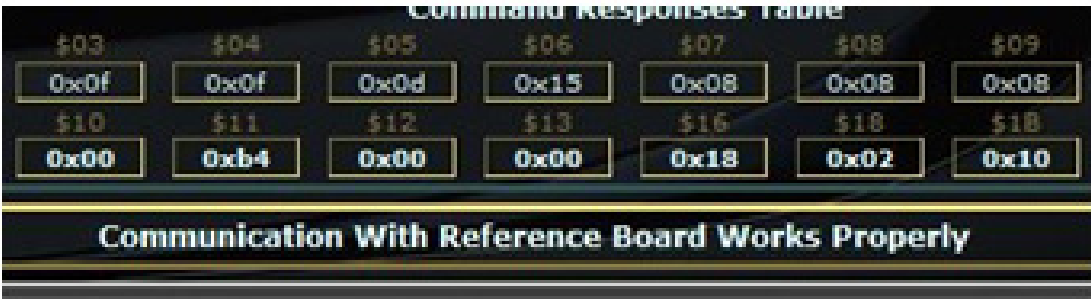


Figure 16. Communication With Reference Board Works Properly Window

6.3 MicroController Abstraction Layer (MCAL)

A Microcontroller Abstraction Layer (MCAL) is defined in order to provide basic MCU drivers to the SW Reference Platform upper Layers. The primary intent is to allow the software developer to easily modify source code or replace the microcontroller - for example, use of S12X 16-bit MCU - with no modification of the Complex drivers (i.e. ASBC, SQUIB or ACC). Thanks to the MCAL, a software developer can maximize re-use of the SW Reference Platform APIs in order to build their own SW application.

RDAIRBAGPSI5 can be configured to modify the MCU Software code using CodeWarrior to download a customized firmware. The following sections describe all steps required to configure RDAIRBAGPSI5 for MCU Software development.

6.3.1 Installing CodeWarrior 10.5 or Greater

This procedure explains how to obtain and install the latest version of CodeWarrior 10.5 or greater.

Notes: The sample software in this kit requires CodeWarrior 10.5 or greater. If CodeWarrior 10.5 or greater is already on your system, the steps in this section can be skipped.

1. Obtain the latest CodeWarrior 10.5 (or greater) installer file from freescale.com/codewarrior.
2. Run the executable file and follow the instructions.

During the installation, there is a request to select components to install. User must install at least the Qorivva component. Select the Qorivva component and click on "Next" to complete the installation.

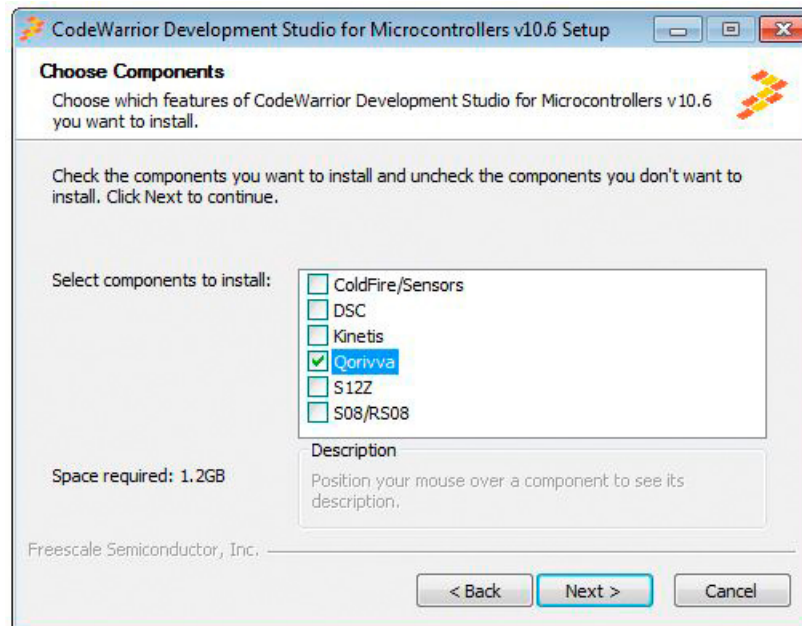


Figure 17. CodeWarrior Choose Components

6.3.2 Interface

The Airbag Reference Platform (ARP) may be used with the P&E's USB BDM Multilink which provides an easy-to-use debug and programming interface for Freescale's Power Architecture® MPC5xx line of microprocessors. This accessory will be needed to flash the MCU using Freescale CodeWarrior 10.5 or greater. See [Figure 18](#).



Figure 18. P&E USB Multilink Debugger

6.3.3 Configuring the Hardware using CodeWarrior

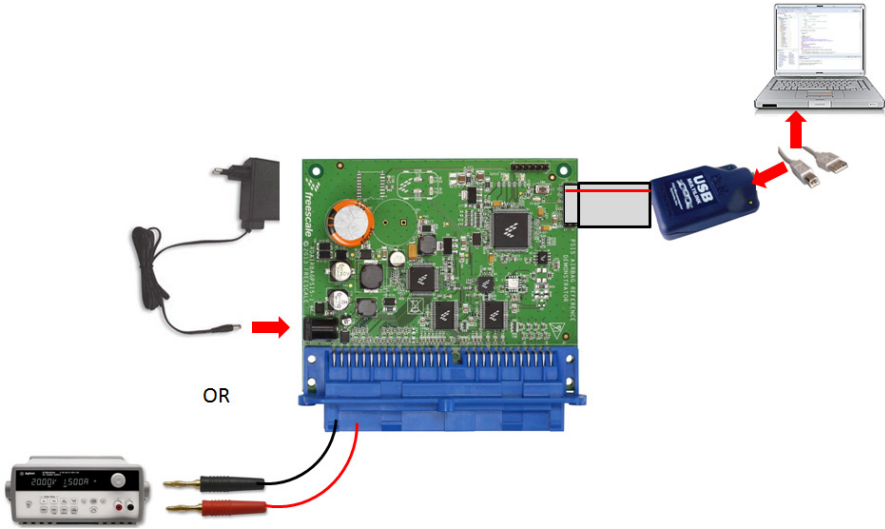


Figure 19. RDAIRBAGPSI5 Configured for MCU Software Development

In order to perform the demonstration examples, first setup the evaluation board hardware and software as follows:

1. Connect the P&E USB Multilink Debugger between the reference design board and the computer.
2. Wait until P&E USB Multilink Debugger drivers installation is completed (during first connection, drivers for the device have to be installed. This can take several minutes). When finished, a status message is displayed in the Windows taskbar and confirms the appropriate drivers were installed correctly.
3. Launch the CodeWarrior Suite.
4. Connect the power supply, either using a power plug or lab power supply.

CAUTION

Please pay attention to the power supply's polarity.
(DO NOT connect both power supply's inputs).

5. Switch on the power supply at 5.2 to 20 V.
6. Connect ECU wiring harness to the ARP blue connector.
7. Start development of your application using CodeWarrior.

6.4 Complex Drivers

6.4.1 Airbag System Basis Chip (ASBC) SW Driver

Table 22: Airbag System Basis Chip SW Driver API

Function Name	Function Parameters	Return Type	Function Description
Asbc_Init	Spi_Channel [in] *Config [in]	Asbc_ReturnType	Initialize the Airbag System Basis Chip and returns the confirmation of initialization. Multiple initialization configuration is supported via the Config parameter.
Asbc_GetStatus	Spi_Channel [in] *Status [out]	Asbc_ReturnType	Return the status of the ASBC. Only the general statuses are reported via this service.
Asbc_SetAnlMuxSource	Spi_Channel [in] Source [in]	Asbc_ReturnType	Allow to change the analog parameter which is connected to the AOUT output.
Asbc_SetDcsMuxSource	Spi_Channel [in] Source [in] Voltage [in]	Asbc_ReturnType	Determines which DC sensor input channel shell be connected for diagnostic output.
Asbc_SetVregMode	Spi_Channel [in] *Config [in]	Asbc_ReturnType	Set the ASBC Voltage regulator. Various configurations of voltage regulators are supported via the Asbc_VregConfig container.
Asbc_GetVregStatus	Spi_Channel [in] *Status [out]	Asbc_ReturnType	Return the status of the ASBC Voltage regulators. This also contains the Boost and Buck statuses.
Asbc_SetPsi5Mode	Spi_Channel [in] *Config [in]	Asbc_ReturnType	Set the ASBC PSI5 four satellite sensor interface. Various configurations of PSI5 interface are supported via the Asbc_Psi5Config container.
Asbc_GetPsi5Status	Spi_Channel [in] *Status [out]	Asbc_ReturnType	Return the status of the ASBC PSI5 interface.
Asbc_SetLinMode	Spi_Channel [in] *Config [in]	Asbc_ReturnType	Set the ASBC LIN transceiver mode. Via the Asbc_LinConfig configuration container various configurations are supported.
Asbc_GetLinStatus	Spi_Channel [in] *Status [out]	Asbc_ReturnType	Return the ASBC LIN transceiver status.
Asbc_SetGpo	Spi_Channel [in] GpoChannel [in] GpoPwmDutyCycle [in] GpoDriverConfig [in]	Asbc_ReturnType	Set the ASBC output channel mode. Various configuration for each output channel are supported via the Asbc_GpoDriverConfig configuration container.
Asbc_GetGpoStatus	Spi_Channel [in] GpoChannel [in] *Status [out]	Asbc_ReturnType	Return the ASBC output channel status. This includes the high/low-side selection, thermal shutdown and the voltage level.

Table 22: Airbag System Basis Chip SW Driver API (continued)

Asbc_ReadSensor	Spi_Channel [in] SequenceIdentifier [in] LogicalChannel [in]	Asbc_ReturnType	This function provides sensor request/response to retrieve sensor data from satellite interface block.
Asbc_FeedWatchdog	Spi_Channel [in] WD_Polarity [in]	Asbc_ReturnType	Update the ASBC Watchdog. A successful watchdog refresh is an SPI command (high), following another SPI command (low).
Asbc_ProgramCmd	Spi_Channel [in] Command [in] Data [in] SpiResponse [out]	Asbc_ReturnType	Send any ASBC command to the device and read its response.

6.4.2 ASBC API Parameters Detail

Brief description of input and output API parameters is in the following paragraphs. Descriptions contain only a verbal description of the parameter. Values which can variable acquired are described in the header file MC33789.h.

Parameters of the Asbc_Init API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Config (Asbc_ConfigType) - input configuration structure:
 - Asbc_SafingThreshold0 - 8 bits safing 0 threshold value
 - Asbc_SafingDwellExt0 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold0
 - Asbc_SafingThreshold1 - 8 bits safing 1 threshold value
 - Asbc_SafingDwellExt1 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold1
 - Asbc_SafingThreshold2 - 8 bits safing 2 threshold value
 - Asbc_SafingDwellExt2 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold2
 - Asbc_SafingThreshold3 - 8 bits safing 3 threshold value
 - Asbc_SafingDwellExt3 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold3
 - Asbc_SafingThreshold4 - 8 bits safing 4 threshold value
 - Asbc_SafingDwellExt4 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold4
 - Asbc_SafingThreshold5 - 8 bits safing 5 threshold value
 - Asbc_SafingDwellExt5 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold5
 - Asbc_SafingThreshold6 - 8 bits safing 6 threshold value
 - Asbc_SafingDwellExt6 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold6
 - Asbc_SafingThreshold7 - 8 bits safing 7 threshold value
 - Asbc_SafingDwellExt7 - extension of the arming pulse width (either 255 ms or 2.0 s) for threshold7

Parameters of the Asbc_GetStatus API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Status (Asbc_StatusType) output status structure containing the common status of the ASBC device:
 - Asbc_VregSyncSuppOverTemp - Sync supply over-temperature error
 - Asbc_VregSensRegulOverTemp - DC sensor regulator over-temperature error
 - Asbc_VregBoostOverTemp - Boost supply over-temperature error
 - Asbc_VregIgnState
 - Asbc_WakeupPinState - wake-up pin state
 - Asbc_WdogState - watchdog state
 - Asbc_WdogErrStatus - watchdog error status
 - Asbc_SafingSequenceErr - safing sequence error

- Asbc_SafingOffsetErr - safing offset error
- Asbc_SafingMode - safing mode status
- Asbc_SafingDataCount - number of digital sensor messages received with valid sensor data
- Safing threshold settings - these parameters are returned the same values as described in the initialization function
- ASBC_Init

Parameters of the Asbc_SetAnIMuxSource API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Source (Asbc_AnIMuxSourceType) input parameter - analog source which will be connected to the MUX input

Parameters of the Asbc_SetDcsMuxSource API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Source (Asbc_DcsMuxSourceType) input parameter - sensor channel selection determines which DC sensor input shall be connected for diagnostics output
- Voltage (Asbc_DcsMuxSourceType) input parameter - bias voltage selection determines which regulated voltage shall be used as a bias supply on the DC sensor output stage for diagnostics

Parameters of the Asbc_SetSafingMode API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- SafingMode (Asbc_SafingModeRequestType) input parameter - safing mode request
- SafingTestEnable (Asbc_SafingTestEnableType) input parameter - safing test enable
- SafingLevel (Asbc_SafingLevelType) input parameter - arming output level

Parameters of the Asbc_SetVregMode API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Config (Asbc_VregConfigType) input configuration parameter - configuration of the ASBC voltage regulator:
 - Asbc_VregSyncSupply (Asbc_VregConfigType) input parameter - Sync supply control
 - Asbc_VregBoost (Asbc_VregBoostType) input parameter - Boost regulator control
 - Asbc_VregBuck (Asbc_VregBuckType) input parameter - Buck regulator control
 - Asbc_VregEnergyReserve (Asbc_VregEnergyReserveType) input parameter - energy reserve control

Parameters of the Asbc_GetVregStatus API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- VregEnergyReserveTest (Asbc_VregEnergyReserveTestType) input parameter - energy reserve test diagnostic control
- Status (Asbc_VregStatusType) output structure containing the status of the ASBC voltage regulators:
 - Asbc_VregBoost (Asbc_VregStatBoostType) - report boost voltage less/greater than threshold (~80% of target)
 - Asbc_VregChargDischarFault (Asbc_VregStatChargDischarFaultType) - CER charge/discharge switch failure status
 - Asbc_VregSyncSupply (Asbc_VregSyncSupplyType) - Sync supply status
 - Asbc_VregBoostEnable (Asbc_VregBoostType) - Boost regulator status
 - Asbc_VregBuckEnable (Asbc_VregBuckType) - Buck regulator status
 - Asbc_VregEnergyReserve (Asbc_VregEnergyReserveType) - energy reserve status
 - Asbc_VregEnergyReserveValue (unit8) - energy reserve test diagnostic status

Parameters of the `Asbc_SetPsi5Mode` API function:

- `Spi_Channel` (`Asbc_SpiChannelType`) - logical SPI channel number (not physical SPI channel)
- `Config` (`Asbc_Psi5ConfigType`) input configuration structure of the ASBC PSI5 interface:
 - `Asbc_PSI5Chann1Mode` (`Asbc_PSI5Chann1ModeType`) - PSI5 channel 1 mode - Synchronous SATSYNC (Steered Mode) or Synchronous TDM Mode
 - `Asbc_PSI5Chann1Enable` (`Asbc_PSI5Chann1EnableType`) - PSI5 channel 1 enable/disable
 - `Asbc_PSI5Chann1SynPuls` (`Asbc_PSI5Chann1SynPulsType`) - PSI5 channel 1 sync pulse enable/disable
 - `Asbc_PSI5Chann2Mode` (`Asbc_PSI5Chann2ModeType`) - PSI5 channel 2 mode - Synchronous SATSYNC (Steered Mode) or Synchronous TDM Mode
 - `Asbc_PSI5Chann2Enable` (`Asbc_PSI5Chann2EnableType`) - PSI5 channel 2 enable/disable
 - `Asbc_PSI5Chann2SynPuls` (`Asbc_PSI5Chann2SynPulsType`) - PSI5 channel 2 sync pulse enable/disable
 - `Asbc_PSI5Chann3Mode` (`Asbc_PSI5Chann3ModeType`) - PSI5 channel 3 mode - Synchronous SATSYNC (Steered Mode) or Synchronous TDM Mode
 - `Asbc_PSI5Chann3Enable` (`Asbc_PSI5Chann3EnableType`) - PSI5 channel 3 enable/disable
 - `Asbc_PSI5Chann3SynPuls` (`Asbc_PSI5Chann3SynPulsType`) - PSI5 channel 3 sync pulse enable/disable
 - `Asbc_PSI5Chann4Mode` (`Asbc_PSI5Chann4ModeType`) - PSI5 channel 4 mode - Synchronous SATSYNC (Steered Mode) or Synchronous TDM Mode
 - `Asbc_PSI5Chann4Enable` (`Asbc_PSI5Chann4EnableType`) - PSI5 channel 4 enable/disable
 - `Asbc_PSI5Chann4SynPuls` (`Asbc_PSI5Chann4SynPulsType`) - PSI5 channel 4 sync pulse enable/disable

Parameters of the `Asbc_GetPsi5Status` API function:

- `Spi_Channel` (`Asbc_SpiChannelType`) - logical SPI channel number (not physical SPI channel)
- `Status` (`Asbc_Psi5StatusType`) output structure containing the status of the ASBC PSI5 interface: - returned parameters are the same as are described in `Asbc_SetPsi5Mode` function above

Parameters of the `Asbc_SetLinMode` API function:

- `Spi_Channel` (`Asbc_SpiChannelType`) - logical SPI channel number (not physical SPI channel)
- `Config` (`Asbc_LinConfigType`) input configuration structure of the ASBC LIN bus interface:
 - `Asbc_LinSlewRate` (`Asbc_LinSlewRateType`) - LIN slew rate selection
 - `Asbc_LinRXDMode` (`Asbc_LinRXDModeType`) - Rx/D output function
 - `Asbc_LinRXOut` (`Asbc_LinRXOutType`) - Rx output selection (for Rx/D satellite function)

Parameters of the `Asbc_GetLinStatus` API function:

- `Spi_Channel` (`Asbc_SpiChannelType`) - logical SPI channel number (not physical SPI channel)
- `Status` (`Asbc_LinStatusType`) output structure containing the status of the ASBC LIN bus interface:
 - `Asbc_LinSlewRate` (`Asbc_LinSlewRateType`) - LIN slew rate selection
 - `Asbc_LinRXDMode` (`Asbc_LinRXDModeType`) - Rx/D output function
 - `Asbc_LinRXOut` (`Asbc_LinRXOutType`) - Rx output selection (for Rx/D satellite function)

Parameters of the `Asbc_SetGpo` API function:

- `Spi_Channel` (`Asbc_SpiChannelType`) - logical SPI channel number (not physical SPI channel)
- `GpoChannel` (`Asbc_GpoChannelType`) - selected GPO pin
- `GpoPwmDutyCycle` (`Asbc_GpoPwmDutyCycleType`) - output PWM duty cycle
- `GpoDriverConfig` (`Asbc_GpoDriverConfigType`) - HS/LS driver configuration selection

Parameters of the Asbc_GetGpoStatus API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- GpoChannel (Asbc_GpoChannelType) - selected GPO pin
- Status (Asbc_GpoStatusType) output structure containing the status of the selected output:
 - Asbc_GpoDriverConfig - HS/LS driver configuration selection
 - Asbc_GpoDriverOn13 - driver ON 1/3 VPWR comparator result
 - Asbc_GpoDriverOn23 - driver ON 2/3 VPWR comparator result
 - Asbc_GpoDriverOff13 - driver OFF 1/3 VPWR comparator result
 - Asbc_GpoDriverOff23 - driver OFF 2/3 VPWR comparator result

Parameters of the Asbc_ReadSensor API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- SequenceIdentifier (Asbc_PSI5SequenceIdentifierType) - PSI5 sequence identifier (used for synchronizing samples)
- LogicalChannel (Asbc_PSI5LogicalChannelType) - PSI5 logical channel selection
- SensorData (unit16) - data from selected satellite sensor
- SensorStatus (Asbc_SensorStatusType) - satellite sensor response status

Parameters of the Asbc_FeedWatchdog API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- WD_Polarity (Asbc_WdLevelType) - watchdog polarity value

Parameters of the Asbc_ProgramCmd API function:

- Spi_Channel (Asbc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Command (Asbc_SpiChannelType) - non sensor command
- Data (unit16) - data
- SpiResponse (unit16) - response to the sent command

6.5 Central Accelerometer Driver

The Central Accelerometer Driver (ACC) is created as a separate software module. The main advantage is full HW abstraction and API independence used in the MCU family. The driver API covers the entire functionality of the main accelerometer, which means all accelerometer functionality can be controlled using API functions.

The ACC Driver is dependent on the BSD layer (basic SPI driver), and on the GPIO driver (General Purpose Input/Output), which provides basic functions for controlling input/output MCU pins.

Table 23: Central Accelerometer SW Driver API

Function Name	Function Parameters	Return Type	Function Description
Acc_Init	Spi_Channel [in] *Config [in]	Acc_ReturnType	Initialize the central accelerometer device and returns the confirmation of initialization. Multiple initialization configuration is supported via the Config parameter.
Acc_GetStatus	Spi_Channel [in] *Status [out]	Acc_ReturnType	Return the whole status of the Mesquite accelerometer device.
Acc_GetAccelData	Spi_Channel [in] AccelCmdX [in] AccelCmdY [in] *Status [out]	Acc_ReturnType	Read the X and Y axis accelerometer moving values and other necessary statuses.

Table 23: Central Accelerometer SW Driver API (continued)

Acc_ProgramCmd	Spi_Channel [in] RegAddress [in] Data [in] SpiResponse [out]	Acc_ReturnType	Read/write independently any IC register.
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6.5.1 ACC API Parameters Detail Descriptions

A brief description of input and output API parameters is in the following paragraphs. Descriptions contain only a verbal description of the parameter. Values which each variable acquires are described in the header file MMA68xx.h.

Parameters of the Acc_Init API function:

- Spi_Channel (Acc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Config (Acc_ConfigType) - input configuration structure:
 - Acc_ConfSignData - this variable determines the format of acceleration data results
 - Acc_OffsetMoni - offset monitor circuit enable/disable
 - Acc_ArmOutput - mode of operation for the ARM_X/PCM_X and ARM_Y/PCM_Y pins
 - Acc_XAxisSelfTest - enable or disable the self-test circuitry for X axis
 - Acc_YAxisSelfTest - enable or disable the self-test circuitry for Y axis
 - Acc_XLowPassFilter - the low pass filter selection bits independently select a low-pass filter for X axis
 - Acc_YLowPassFilter - the low pass filter selection bits independently select a low-pass filter for Y axis
 - Acc_XArmPulseStretch - pulse stretch time for X arming outputs
 - Acc_YArmPulseStretch - pulse stretch time for Y arming outputs
 - Acc_XArm_PosWin_CountLimit - X axis positive arming window size definitions or arming count limit definitions function (depending on the state of the Acc_ArmOutput variable)
 - Acc_YArm_PosWin_CountLimit - Y axis positive arming window size definitions or arming count limit definitions function (depending on the state of the Acc_ArmOutput variable)
 - Acc_XArm_NegWinSize - X axis negative arming window size definitions (meaning depend on the state of the Acc_ArmOutput variable)
 - Acc_YArm_NegWinSize - Y axis negative arming window size definitions (meaning depend on the state of the Acc_ArmOutput variable)
 - Acc_XArmPositiveThreshold - this value contain the X axis positive threshold to be used by the arming function
 - Acc_YArmPositiveThreshold - this value contain the Y axis positive threshold to be used by the arming function
 - Acc_XArmNegativeThreshold - this value contain the X axis negative thresholds to be used by the arming function
 - Acc_YArmNegativeThreshold - this value contain the Y axis negative thresholds to be used by the arming function

Parameters of the Acc_GetStatus API function:

- Spi_Channel (Acc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Status (Acc_StatusType) output status structure containing the complete status of the ACC device:
 - Acc_SerialNumber - device serial number
 - Acc_LotNumberHigh - device high lot number value
 - Acc_LotNumberMidd - device midd lot number value
 - Acc_LotNumberLow - device low lot number value
 - Acc_PartNumber - device part number
 - Acc_XPositiveTestDeflection - device self test positive deflection values for X axis
 - Acc_YPositiveTestDeflection - self test positive deflection values for Y axis
 - Acc_XFullScaleAccelerationRange - X self test magnitude selection
 - Acc_YFullScaleAccelerationRange - Y self test magnitude selection
 - Acc_DeviceReset - this device reset flag is set during device initialization following a device reset
 - Acc_X_OffsetOverRange - the offset monitor over range flag is set if the acceleration signal of the X axis reaches the specified offset limit

- `Acc_Y_OffsetOverRange` - the offset monitor over range flag is set if the acceleration signal of the Y axis reaches the specified offset limit
- `Acc_SpiMisoError` - the MISO data mismatch flag is set when a MISO Data mismatch fault occurs
- `Acc_DeviceInitFlag` - the device initialization flag is set during the interval between negation of internal reset and completion of internal device initialization
- `Acc_SigmaDeltaOverRange` - the sigma delta modulator over range flag is set if the sigma delta modulator for either axis becomes saturated
- `Acc_InterDataError` - the internal data error flag is set if a customer or OTP register data CRC fault or other internal fault is detected
- `Acc_FuseWarning` - the fuse warn bit is set if a marginally programmed fuse is detected
- `Acc_InitEnd` - the `ENDINIT` bit is a control bit use to indicate that the user has completed all device and system level initialization tests, and that Mesquite will operate in normal mode
- `Acc_SignData` - this parameter determines the format of acceleration data results
- `Acc_OffsetMoni` - offset monitor circuit is enable/disable
- `Acc_ArmOutput` - the ARM Configuration type select the mode of operation for the `ARM_X/PCM_X`, `ARM_Y/PCM_Y` pins
- `Acc_XAxisSelfTest` - enable or disable the self-test circuitry for X axis
- `Acc_YAxisSelfTest` - enable or disable the self-test circuitry for Y axis
- `Acc_XLowPassFilter` - the low pass filter selection bits independently select a low-pass filter for X axis
- `Acc_YLowPassFilter` - the low pass filter selection bits independently select a low-pass filter for Y axis
- `Acc_XArmPulseStretch` - pulse stretch time for X arming outputs
- `Acc_YArmPulseStretch` - pulse stretch time for Y arming outputs
- `Acc_XArm_PosWin_CountLimit` - X axis positive arming window size definitions or arming count limit definitions function (depending on the state of the `Acc_ArmOutput` variable)
- `Acc_YArm_PosWin_CountLimit` - Y axis positive arming window size definitions or arming count limit definitions function (depending on the state of the `Acc_ArmOutput` variable)
- `Acc_Arm_XNegWinSize` - X axis negative arming window size definitions (meaning depend on the state of the `Acc_ArmOutput` variable)
- `Acc_Arm_YNegWinSize` - Y axis negative arming window size definitions (meaning depend on the state of the `Acc_ArmOutput` variable)
- `Acc_XArmPositiveThreshold` - this value contain the X axis positive threshold to be used by the arming function
- `Acc_YArmPositiveThreshold` - this value contain the Y axis positive threshold to be used by the arming function
- `Acc_XArmNegativeThreshold` - this value contain the X axis negative thresholds to be used by the arming function
- `Acc_YArmNegativeThreshold` - this value contain the Y axis negative thresholds to be used by the arming function
- `Acc_CountValue` - value in the register increases by one count every 128 us and the counter rolls over every 32.768 ms
- `Acc_XOffsetCorrection` - the most recent X axis offset correction increment/decrement value from the offset cancellation
- `Acc_YOffsetCorrection` - the most recent Y axis offset correction increment/decrement value from the offset cancellation circuit

Parameters of the `Acc_GetAccelData` API function:

- `Spi_Channel` (`Acc_SpiChannelType`) - logical SPI channel number (not physical SPI channel)
- `AccelCmdX` (`Acc_XAccelerationDataType`) - X axis acceleration data request
- `AccelCmdY` (`Acc_YAccelerationDataType`) - Y axis acceleration data request
- `Status` (`Acc_AccelStatusType`) output data structure containing the accelerometer X/Y moving values and device status:
 - `AccelDataX` - X axis acceleration data
 - `AccelDataY` - Y axis acceleration data
 - `AccelRespTypeX` - type of the X axis acceleration response
 - `AccelRespTypeY` - type of the Y axis acceleration response
 - `Acc_DeviceReset` - device reset flag is set during device initialization following a device reset

- Acc_X_OffsetOverRange - the offset monitor over range flag is set if the acceleration signal of the X axis reaches the specified offset limit
- Acc_Y_OffsetOverRange - the offset monitor over range flag is set if the acceleration signal of the Y axis reaches the specified offset limit
- Acc_SpiMisoError - the MISO data mismatch flag is set when a MISO Data mismatch fault occurs
- Acc_DeviceInitFlag - the device initialization flag is set during the interval between negation of internal reset and completion of internal device initialization
- Acc_SigmaDeltaOverRange - the sigma delta modulator over range flag is set if the sigma delta modulator for either axis becomes saturated
- Acc_InterDataError - the internal data error flag is set if a customer or OTP register data CRC fault or other internal fault is detected
- Acc_FuseWarning - the fuse warn bit is set if a marginally programmed fuse is detected
- Acc_CountValue - value in the register increases by one count every 128 us and the counter rolls over every 32.768 ms

Parameters of the Acc_ProgramCmd API function:

- Spi_Channel (Acc_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- RegAddress (unit16) - address of the selected IC register
- Data (unit16) - data
- SpiResponse (unit16) - response to the sent command

6.6 SQUIB Driver

The SQUIB driver is created as a separate software module. The main advantage is full HW abstraction and API independence used in the MCU family. The driver API covers the entire functionality of the squib driver, which means all firing commands and devices statuses can be controlled by API functions.

The SQUIB Driver is dependent on the BSD layer (basic SPI communication) and on the GPIO driver (General Purpose Input/Output), which provides basic functions for reading status on the arming pins.

Table 24: SQUIB SW Driver API

Function Name	Function Parameters	Return Type	Function Description
Squib_Init	Spi_Channel [in]	Squib_ReturnType	Initialize the SQUIB device and returns the confirmation of the initialization.
Squib_Fire	Spi_Channel [in] Squib_Fire [in]	Squib_ReturnType	This function provide explosion of the selected SQUIB driver
Squib_GetStatus	Spi_Channel [in] *Status [out]	Squib_ReturnType	Return the status of the SQUIB drivers (1A, 1B, 2A and 2B) and common status of the SQUIB IC.
Squib_ProgramCmd	Spi_Channel [in] Command [in] Data [in] Delay [in] SpiResponse [out]	Squib_ReturnType	Send any SQUIB command to the IC device and read its response.

6.6.1 SQUIB API Parameters Detail Descriptions

A brief description of input and output API parameters is in the following paragraphs. Descriptions contain only a written description of the parameter. Values which each variable acquires are described in the header file MC33797.h.

Parameters of the Squib_Init API function:

- Spi_Channel (Squib_SpiChannelType) - logical SPI channel number (not physical SPI channel)

Parameters of the Squib_GetStatus API function:

- Spi_Channel (Squib_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Status (Squib_StatusType) output status structure containing the complete status of the ACC
 - Squib_Stat1ACurrTime - firing current in 1A squib line and records the "ON" time in which the IMEAS current is above the threshold for 1A squib
 - Squib_Stat1BCurrTime - firing current in 1B squib line and records the "ON" time in which the IMEAS current is above the threshold for 1B squib
 - Squib_Stat2ACurrTime - firing current in 2A squib line and records the "ON" time in which the IMEAS current is above the threshold for 2A squib
 - Squib_Stat2BCurrTime - firing current in 2B squib line and records the "ON" time in which the IMEAS current is above the threshold for 2B squib
 - Squib_Stat1ACurrent - line 1A FET driver current limit measurement status
 - Squib_Stat1BCurrent - line 1B FET driver current limit measurement status
 - Squib_Stat2ACurrent - line 2A FET driver current limit measurement status
 - Squib_Stat2BCurrent - line 2B FET driver current limit measurement status
 - Squib_Stat1ALowSideThermalShut - 1A Low-side Squib driver thermal shutdown status
 - Squib_Stat1AHighSideThermalShut - 1A High-side Squib driver thermal shutdown status
 - Squib_Stat1BLowSideThermalShut - 1B Low-side Squib driver thermal shutdown status
 - Squib_Stat1BHighSideThermalShut - 1B High-side Squib driver thermal shutdown status
 - Squib_Stat2ALowSideThermalShut - 2A Low-side Squib driver thermal shutdown status
 - Squib_Stat2AHighSideThermalShut - 2A High-side Squib driver thermal shutdown status
 - Squib_Stat2BLowSideThermalShut - 2B Low-side Squib driver thermal shutdown status
 - Squib_Stat2BHighSideThermalShut - 2B High-side Squib driver thermal shutdown status
 - Squib_Stat1VdiagResult - firing supply voltage (VDIAG_1) diagnostics - voltage level on the VDIAG_1 pin
 - Squib_Stat1HSSafingSens - High-side Safing sensor diagnostics - monitors the VFIRE_XX pin connection to the VDIAG_1 pin
 - Squib_Stat2VdiagResult - firing supply voltage (VDIAG_2) diagnostics - voltage level on the VDIAG_2 pin
 - Squib_Stat2HSSafingSens - High-side Safing sensor diagnostics - monitors the VFIRE_XX pin connection to the VDIAG_2 pin
 - Squib_1AShBatt - Squib short-to-battery diagnostics - voltage level on the SENSE_1A pin
 - Squib_1AShGnd - Squib short-to-ground diagnostics - voltage level on the SENSE_1A pin
 - Squib_1BShBatt - Squib short-to-battery diagnostics - voltage level on the SENSE_1B pin
 - Squib_1BShGnd - Squib short-to-ground diagnostics - voltage level on the SENSE_1B pin
 - Squib_2AShBatt - Squib short-to-battery diagnostics - voltage level on the SENSE_2A pin
 - Squib_2AShGnd - Squib short-to-ground diagnostics - voltage level on the SENSE_2A pin
 - Squib_2BShBatt - Squib short-to-battery diagnostics - voltage level on the SENSE_2B pin
 - Squib_2BShGnd - Squib short-to-ground diagnostics - voltage level on the SENSE_2B pin
 - Squib_Stat1ALowSideCont - continuity status for the Low-side driver SQB_LO_1A connection
 - Squib_Stat1BLowSideCont - continuity status for the Low-side driver SQB_LO_1B connection
 - Squib_Stat2ALowSideCont - continuity status for the Low-side driver SQB_LO_2A connection
 - Squib_Stat2BLowSideCont - continuity status for the Low-side driver SQB_LO_2B connection
 - Squib_1AOpnShBatt - Squib 1A harness short-to-battery status with an open Squib
 - Squib_1AOpnShGnd - Squib 1A harness short-to-ground status with an open Squib
 - Squib_1BOpnShBatt - Squib 1B harness short-to-battery status with an open Squib
 - Squib_1BOpnShGnd - Squib 1B harness short-to-ground status with an open Squib
 - Squib_2AOpnShBatt - Squib 2A harness short-to-battery status with an open Squib
 - Squib_2AOpnShGnd - Squib 2A harness short-to-ground status with an open Squib
 - Squib_2BOpnShBatt - Squib 2B harness short-to-battery status with an open Squib
 - Squib_2BOpnShGnd - Squib 2B harness short-to-ground status with an open Squib
 - Squib_StatVfireBTested - reports VFIRE testing has been finished
 - Squib_StatVfire - reports of the voltage level on the VFIRE_XX pin

- Squib_StatV1diagV1 - firing supply voltage status - VDIAG_V1 voltage on the VDIAG1 pin
- Squib_StatV1diagV2 - firing supply voltage status - VDIAG_V2 voltage on the VDIAG1 pin
- Squib_StatV1diagV3 - firing supply voltage status - VDIAG_V3 voltage on the VDIAG1 pin
- Squib_StatV1diagV4 - firing supply voltage status - VDIAG_V4 voltage on the VDIAG1 pin
- Squib_StatV2diagV1 - firing supply voltage status - VDIAG_V1 voltage on the VDIAG2 pin
- Squib_StatV2diagV2 - firing supply voltage status - VDIAG_V2 voltage on the VDIAG2 pin
- Squib_StatV2diagV3 - firing supply voltage status - VDIAG_V3 voltage on the VDIAG2 pin
- Squib_StatV2diagV4 - firing supply voltage status - VDIAG_V4 voltage on the VDIAG2 pin
- Squib_StatFen1 - status of the FEN_1 arming input pin
- Squib_StatFen2 - status of the FEN_2 arming input pin
- Squib_StatFen1Latch - FEN1 latch status
- Squib_StatFen2Latch - FEN2 latch status
- Squib_StatRdiag - reports status of the R_DIAG resistor
- Squib_StatRlimit1 - reports the R_LIMIT_1 resistor value - reference currents derived by the R_LIMIT_1 and R_LIMIT_2 resistors
- Squib_StatRlimit2 - reports the R_LIMIT_2 resistor value - reference currents derived by the R_LIMIT_1 and R_LIMIT_2 resistors
- Squib_DeviceType - identifier the squib IC as a four- or two-channel squib driver IC
- Squib_StatVfireRtn1 - reports the resistance on the VFIRE_RTn1 pin for open pin connections
- Squib_StatVfireRtn2 - reports the resistance on the VFIRE_RTn2 pin for open pin connections
- Squib_Stat1AResistance - Squib 1A resistance value
- Squib_Stat1BResistance - Squib 1B resistance value
- Squib_Stat2AResistance - Squib 2A resistance value
- Squib_Stat2BResistance - Squib 2B resistance value
- Squib_Stat1ALoopsShorts - reports shorts between 1A squib lines and other firing loops
- Squib_Stat1BLoopsShorts - reports shorts between 1B squib lines and other firing loops
- Squib_Stat2ALoopsShorts - reports shorts between 2A squib lines and other firing loops
- Squib_Stat2BLoopsShorts - reports shorts between 2B squib lines and other firing loops
- Squib_Stat1ALoopsShortsAddIC - reports shorts between squib 1A loop and other loops on additional ICs
- Squib_Stat1BLoopsShortsAddIC - reports shorts between squib 1B loop and other loops on additional ICs
- Squib_Stat2ALoopsShortsAddIC - reports shorts between squib 2A loop and other loops on additional ICs
- Squib_Stat2BLoopsShortsAddIC - reports shorts between squib 2B loop and other loops on additional ICs

Parameters of the Squib_Fire API function:

- Spi_Channel (Squib_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Squib_Fire (Squib_FireType) - firing commands for squibs pairs or for separate Low/High-side

Parameters of the Squib_ProgramCmd API function:

- Spi_Channel (Squib_SpiChannelType) - logical SPI channel number (not physical SPI channel)
- Command (Squib_ProgCmdType) - Squib command
- Data (unit8) - data
- Delay (unit8) - Squib diagnostic delay time
- SpiResponse (unit8) - response to the sent command

7 Schematics

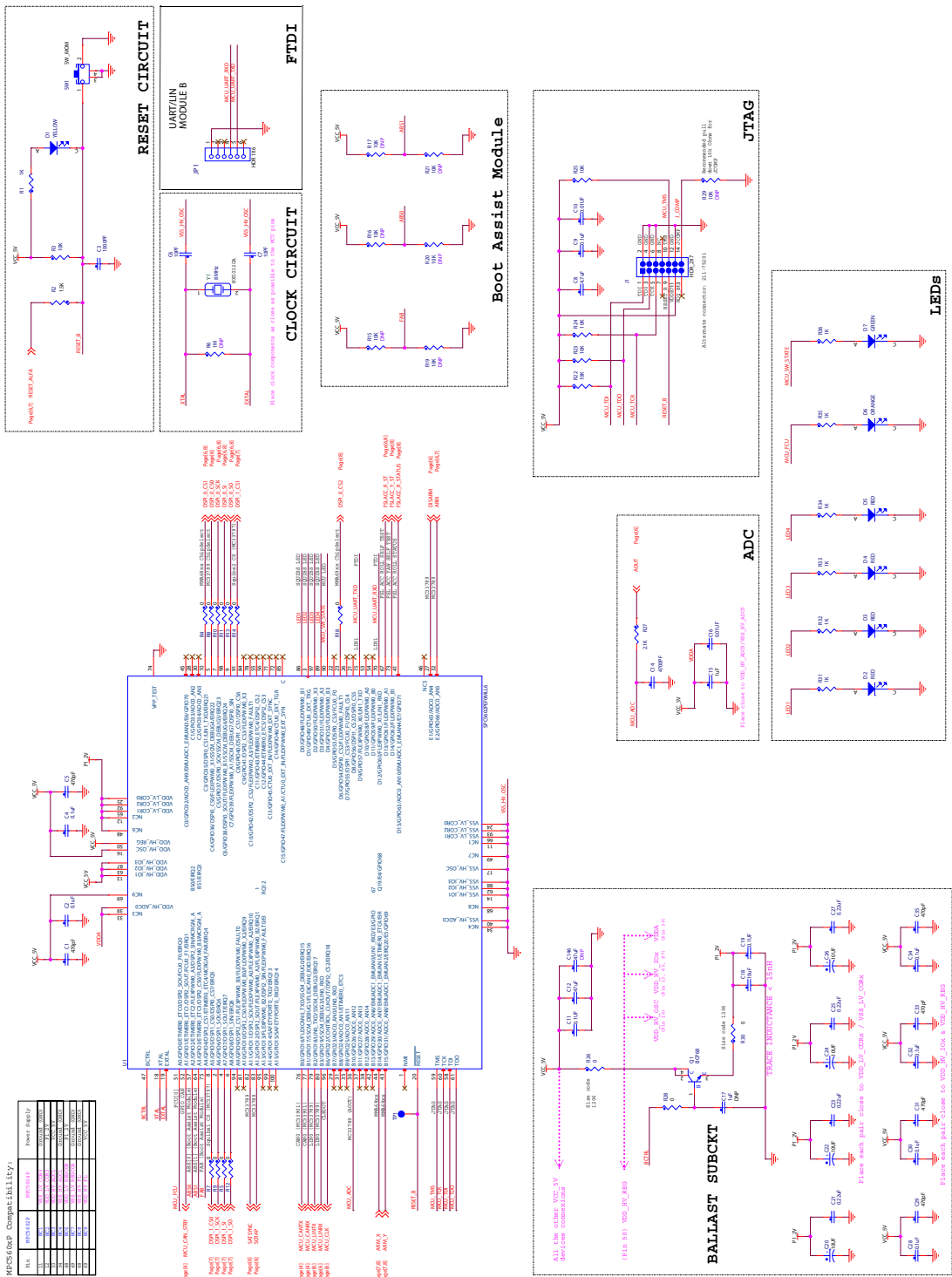


Figure 20. Evaluation Board Schematic Part 1 - MPC5602P MCU

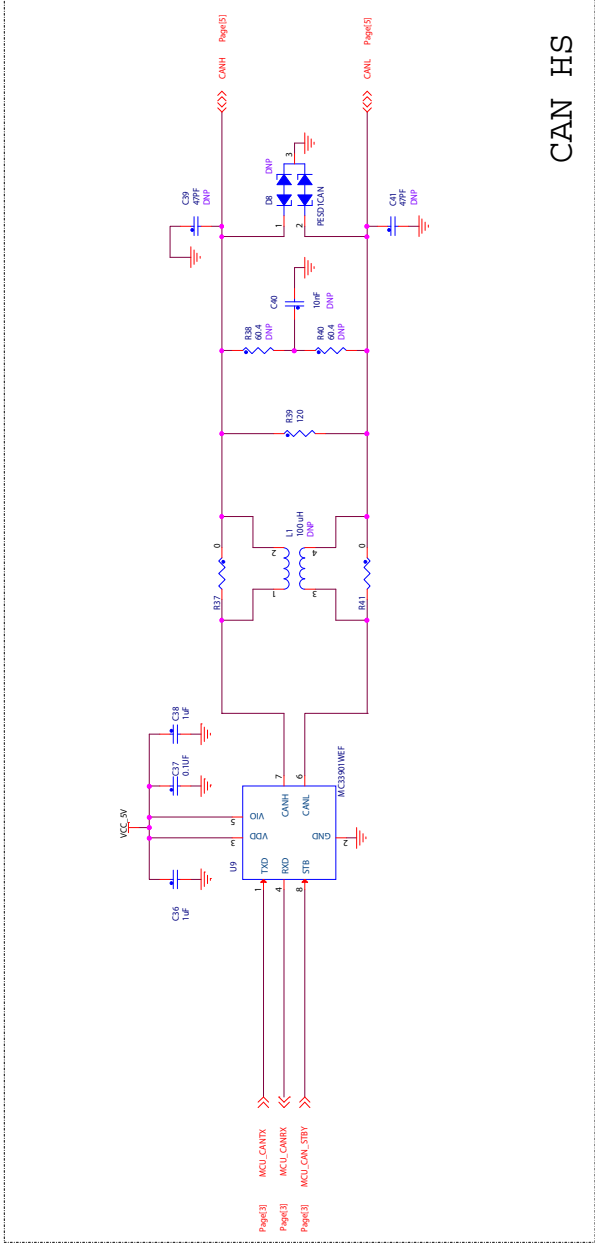


Figure 21. Evaluation Board Schematic Part 2 - CAN High Speed I/F

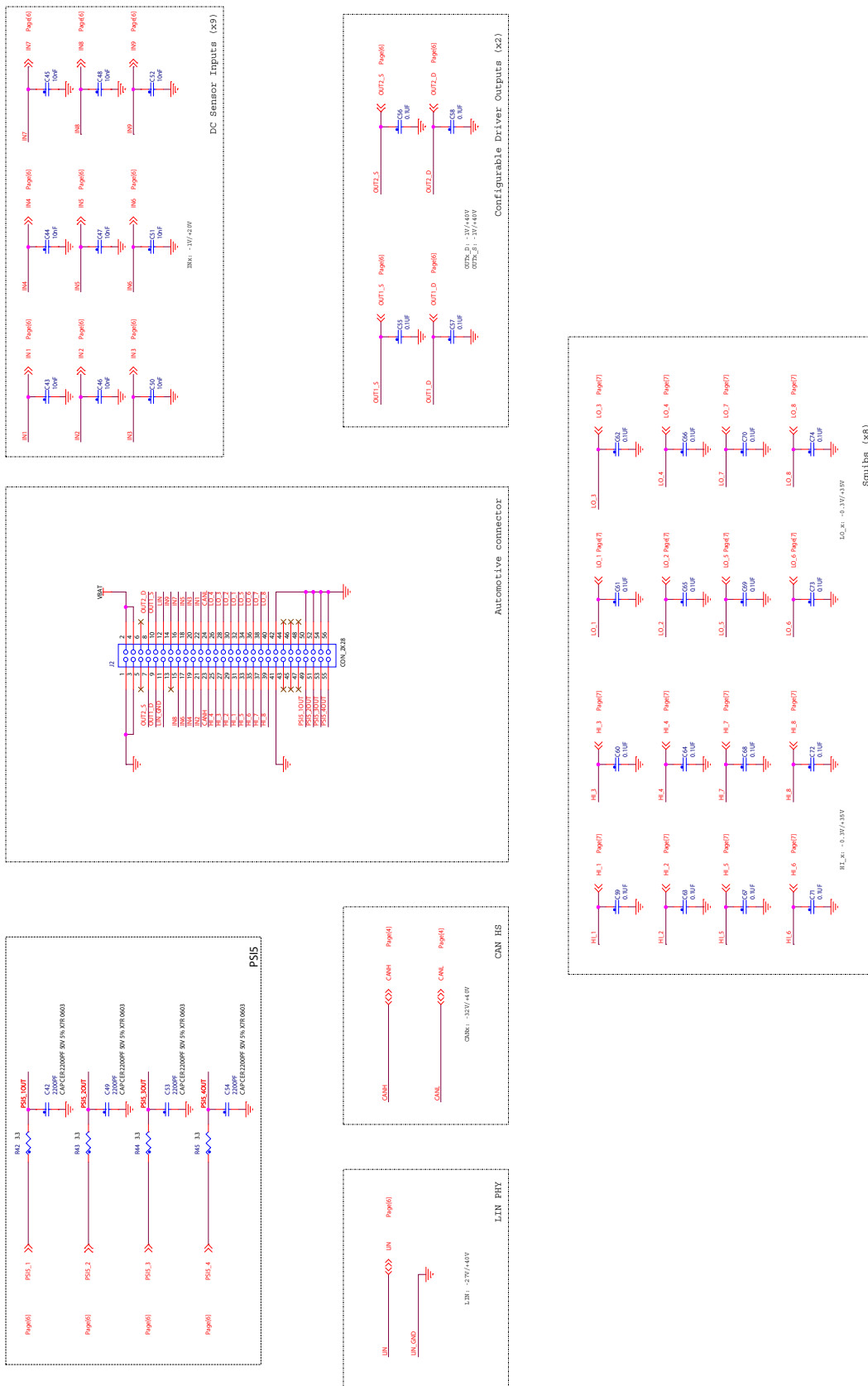


Figure 22. Evaluation Board Schematic Part 3 - Connector I/F

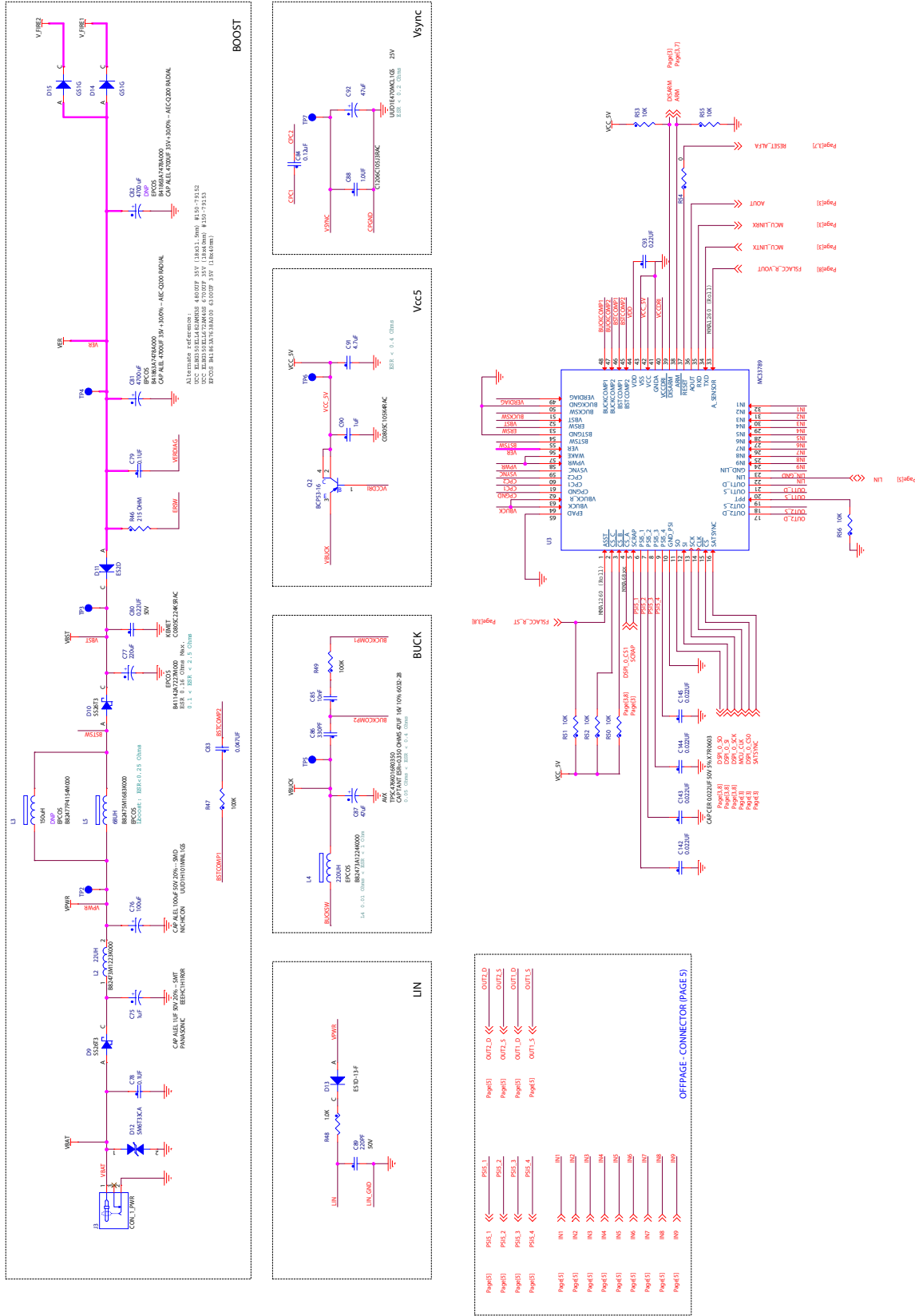


Figure 23. Evaluation Board Part 4 - MC33789

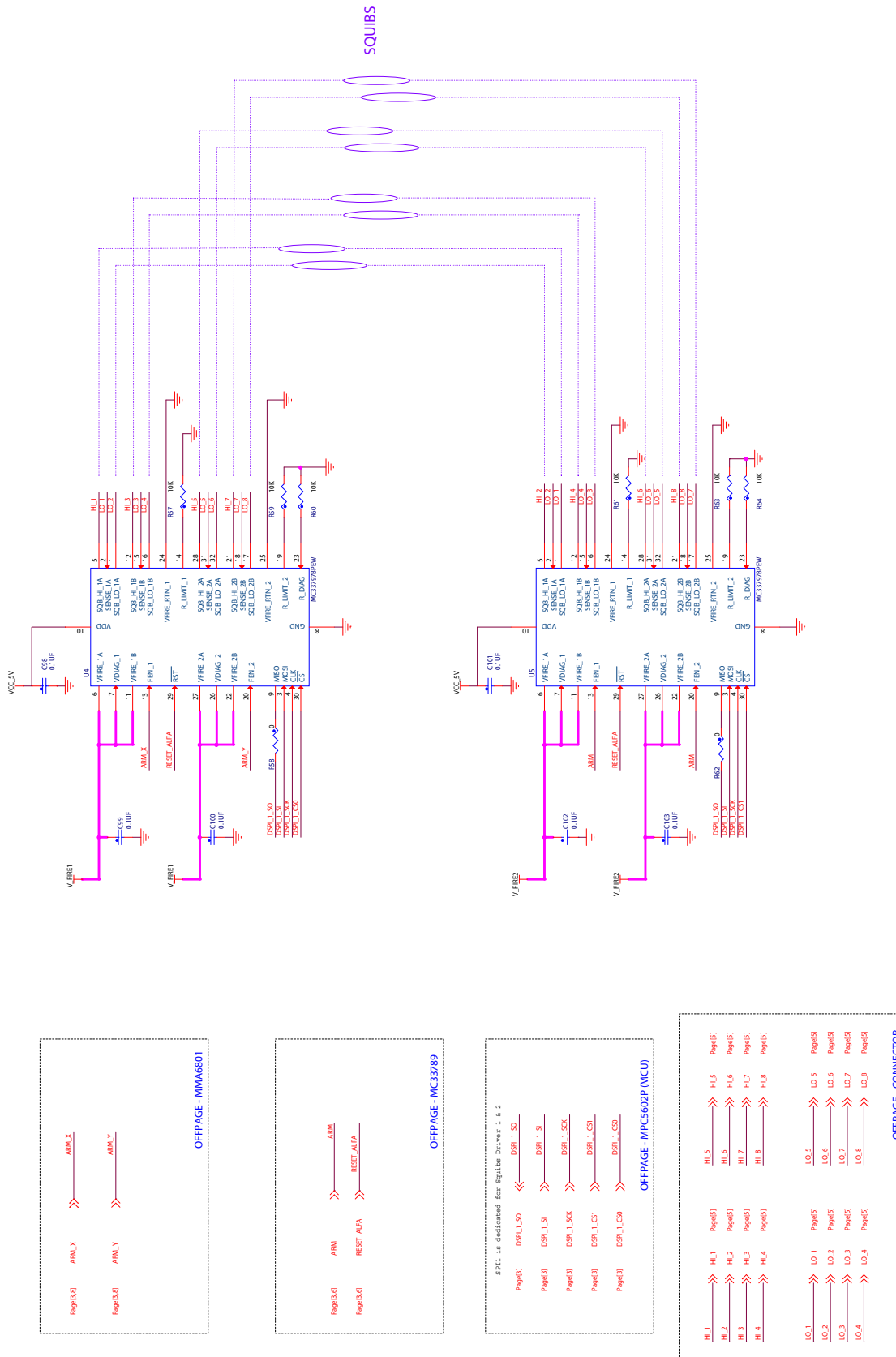
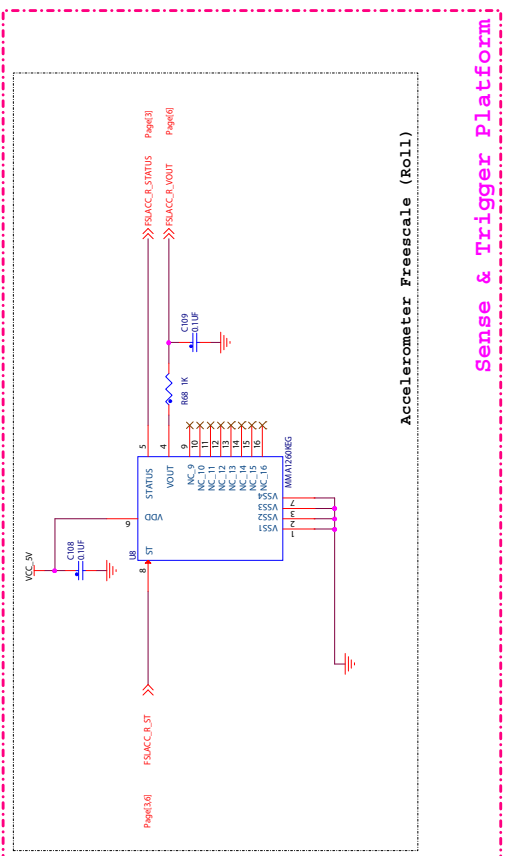
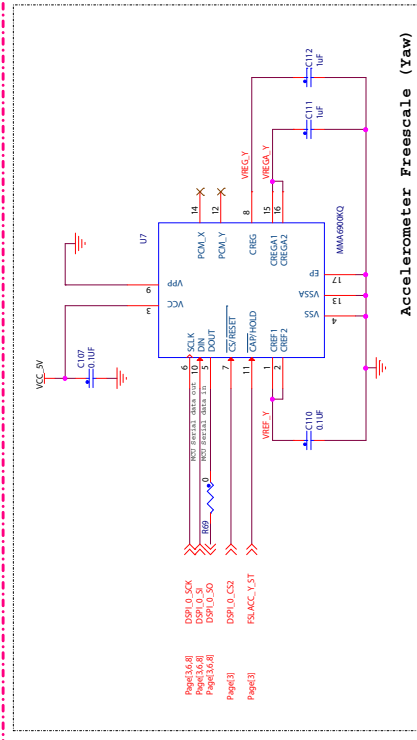
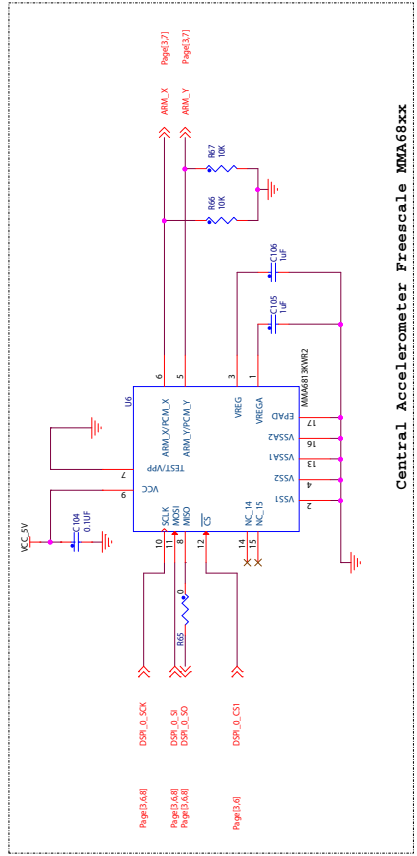


Figure 24. Evaluation Board Schematic Part 5 - MC33797

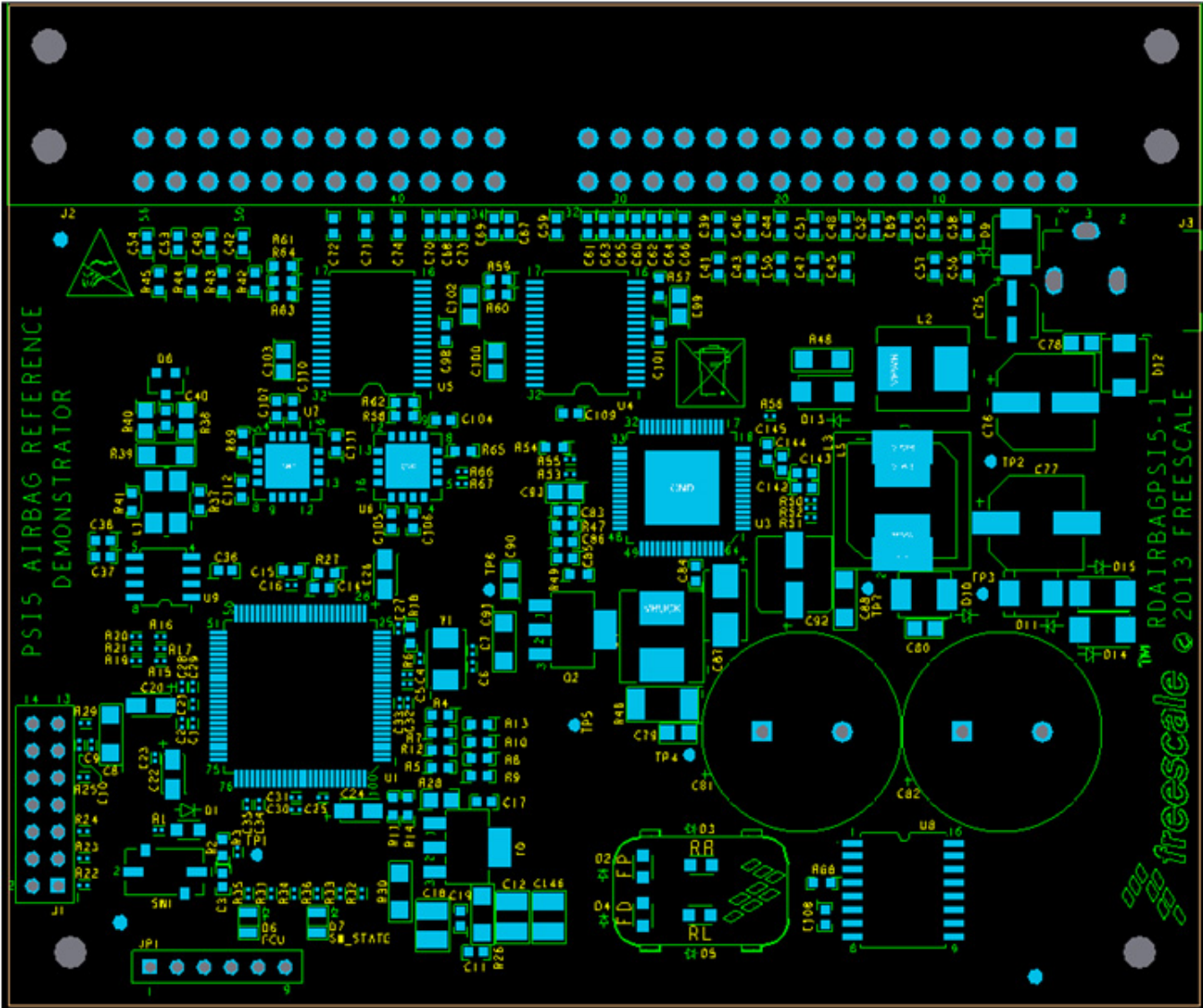


Sense & Trigger Platform

Figure 25. Evaluation Board Schematic Part 6 - Sensors

8 Board Layout

8.1 Assembly Layer Top



9 Bill of Material

Table 25: Bill of Materials ⁽¹⁾

Qty	Schematic Label	Value	Part Number	Description	Package	Assy Opt
Freescale Components						
1	U1		SPC5602PEF0MLL6	Freescale 32-bit MCU	LQFP100	(3)
1	U3		MCZ33789BAE	Freescale Airbag System Basis Chip	LQFP64	(3)
2	U4, U5		MC33797BPEW	Freescale Squibs Driver (4 ch)	SO32	(3)
1	U6		MMA6813KW	Freescale Medium-g XY-axis Crash Sensor	QFN16	(3)
1	U7		MMA6900KQ	Freescale Low-g XY-axis Yaw Sensor	QFN16	(2)
1	U8		MMA1260KEG	Freescale Low-g Z-axis Roll Sensor	SOIC16	(2)
1	U9		MC33901WEF	Freescale CAN High Speed Interface	SO8	(3)
Crystal Oscillators						
1	Y1	8 MHz	NX5032GA-8.000M	NDK XTAL 8 MHz	SMD	(3)
Transistors						
1	Q1	NPN	BCP68T1G	TRAN NPN PWR 20 V 1 A	SOT-223	(3)
1	Q2	PNP	BCP53-16T1G	TRAN PNP GEN 1.5 A 80 V	SOT-223	(3)
LEDs						
1	D1	YELLOW	598-8140-107F	LED YEL SGL 25 mA	0805	
4	D2, D3, D4, D5	RED	HSMH-C170	LED RED SGL 20 mA	0805	
1	D6	ORANGE	598-8130-107F	LED OR SGL 25 mA	0805	
1	D7	GREEN	598-8170-107F	LED GRN SGL 25 mA	0805	
Diodes						
1	D8	PESD1CAN		DIODE BIDIR CAN BUS ESD PROTECTION 200 W 24 V	SOT23	(2)
2	D9, D10	SS26T3		DIODE SCH PWR 2A 60 V	SMB	
1	D11	ES2D		DIODE RECT ULTRAFast 2 A 200 V	DO-214AA	
1	D12	SM6T33CA		DIODE TVS BIDIR 33 V 600 W	DO-214AA	
1	D13	ES1D-13-F		DIODE RECT 1 A 200 V	SMA	
Capacitors						
6	C1,C5,C29,C31,C33,C35	470 pF		CAP CER 470 pF 50 V 5% C0G 0402	0402_CC	
7	C2,C4,C9,C28,C30,C32,C34	0.1 uF		CAP CER 0.1 uF 6.3 V 10% X7R 0402	0402_CC	

Table 25: Bill of Materials ⁽¹⁾ (continued)

1	C3	1000 pF		CAP CER 1000 PF 25 V 5% C0G CC0603	CC0603	
2	C6,C7	10 pF		CAP CER 10 PF 50 V 5% C0G 0402	0402_CC	
2	C8,C91	4.7 uF		CAP CER 4.7uF 25V 10% X7R 1206	CC1206	
2	C10,C16	0.01 uF		CAP CER 0.01 UF 16 V 20% X7R 0402	0402_CC	
30	C11,C19,C37,C55, C56,C57,C58,C59, C60,C61,C62,C63, C64,C65,C66,C67, C68,C69,C70,C71, C72,C73,C74,C98, C101,C104,C107, C108,C109,C110	0.1 uF		CAP CER 0.10 UF 25 V 10% X7R 0603	CC0603	
1	C12	47 uF		CAP CER 47 UF 10 V 10% X7R 1210	CC1210	
1	C14	4700 pF		CAP CER 4700 PF 50 V 10% X7R 0603	CC0603	
7	C15,C36,C38, C105,C106,C111, C112	1 uF		CAP CER 1 UF 25 V 10% X7R 0603	CC0603	
1	C17	1 uF		CAP CER 1 UF 25 V 10% X7R 0603	CC0603	(2)
1	C18	10 uF		CAP CER 10 UF 16 V 10% X7R 1210	CC1210	
4	C20,C22,C24,C26	10 uF	3216-18	CAP TANT 10 UF 16 V 10%	CC3216	
4	C21,C23,C25,C27	0.22 uF		CAP CER 0.22 UF 6.3 V 20% X5R 0402	0402_CC	
2	C39,C41	47 pF		CAP CER 47 PF 50 V 5% C0G 0603	CC0603	(2)
1	C40	10 nF		CAP CER 0.01 UF 50 V 5% X7R 0603	CC0603	(2)
4	C42,C49,C53,C54	2200 pF		CAP CER 2200 PF 50 V 5% X7R 0603	CC0603	
10	C43,C44,C45,C46, C47,C48,C50,C51, C52,C85	10 nF		CAP CER 0.01 UF 50V 5% X7R 0603	CC0603	
1	C75	1 uF		CAP ALEL 1 UF 50 V 20% -- SMT	cce40x54	
1	C76	100 uF		CAP ALEL 100 uF 50 V 20% -- SMD	cce8p3x8p3	
1	C77	220 uF		Epcos - CAP ALEL 220 uF 35 V 20% -- SMD	case_e_al	(3)
6	C78,C79,C99, C100,C102,C103	0.1 uF		CAP CER 0.1 UF 50V 5% X7R 0805	CC0805	
2	C80,C93	0.22 uF		CAP CER 0.22 UF 50 V 10% X7R 0805	CC0805	
2	C81, C82	4700 uF		Epcos - CAP ALEL 4700 UF 35 V +30/0% -- AEC-Q200 RADIAL	cap_pol_7p5_18p5	(2)(3)
1	C83	0.047 uF		CAP CER 0.047 UF 50 V 10% X7R 0603	CC0603	
1	C84	0.12 uF		CAP CER 0.12 UF 50 V 10% X7R 0603	CC0603	

Table 25: Bill of Materials ⁽¹⁾ (continued)

1	C86	330 pF		CAP CER 330 PF 50 V 5% C0G 0603	CC0603	
1	C87	47 uF	6032-28	CAP TANT ESR = 0.350 Ohm 47 UF 16 V 10%	CC6032	
1	C88	1.0 uF		CAP CER 1.0 UF 25 V 5% X7R 1206	CC1206	
1	C89	220 pF		CAP CER 220 PF 50 V 10% X7R 0603	CC0603	
1	C90	1 uF		CAP CER 1 uF 16 V 10% X7R 0805	CC0805	
1	C92	47 uF		CAP ALEL 47 uF 25 V 20% -- SMT	cce6p8x6p8	
4	C142,C143,C144, C145	0.022 uF		CAP CER 0.022 UF 50 V 5% X7R 0603	CC0603	
1	C146	47 uF		CAP CER 47 UF 10 V 10% X7R 1210	CC1210	(2)

Inductors

1	L1	100 uH	B82789C0104N002	Epcos - IND CHK 100 uH 150 mA	1812_4p	(2)(3)
1	L2	22 uH	B82473M1223K000	Epcos - IND PWR 22 UH@100 kHz 1.5 A	5p3_7p5x8p3	(3)
1	L3	150 uH	B82477P4154M000	Epcos - IND PWR 150 uH@100 KHZ 1.7 A	12p5x12p5	(2)(3)
1	L4	220 uH	B82473A1224K000	Epcos - IND PWR 220 UH@100 KHZ 0.49 A	5p3_7p5x8p3	(3)
1	L5	68 uH	B82475M1683K000	Epcos - IND PWR 68 UH@100 KHZ 1.11 A	10x10p4	(3)

Resistors

7	R1,R31,R32,R33, R34,R35,R36	1 KOhm	CRCW04021K00JNED	RES MF 1.0 K 1/16 W 5% 0402	0402_CC	
1	R2	1.5 KOhm	RC0603FR-071K5L	RES MF 1.5 K 1/10 W 1% 0603	RC0603	
13	R3,R22,R23,R24, R25,R50,R51,R52, R53,R55,R56,R66, R67	10 KOhm	CRCW040210K0JNED	RES MF 10 K 1/16 W 5% 0402	0402_CC	
18	R4,R5,R7,R8,R9, R10,R11,R12,R13, R14,R18,R37,R41, R54,R58,R62,R65, R69	0 Ohm	CRCW06030000Z0EA	RES MF 0 Ohm 1/10 W 0603	RC0603	
1	R6	1 MOhm	ERJ-2GEJ105X	RES MF 1.0 M 1/10 W 5% 0402	0402_CC	(2)
7	R15,R16,R17,R19, R20,R21,R29	10 KOhm	CRCW040210K0JNED	RES MF 10 K 1/16 W 5% 0402	0402_CC	(2)
2	R26,R30	0 Ohm	CRCW12060000Z0EA	RES MF 0 Ohm 1/4 W	RC1206	
1	R27	2.1 KOhm	RK73H1JTDD2101F	RES MF 2.1 K 1/10 W 1% 0603	RC0603	
1	R28	0 Ohm	RC0805JR-070RL	RES MF 2.1 K 1/10 W 1% 0603	RC0805	
2	R38,R40	60.4 Ohm	232273466049L	RES MF 60.4 Ohm 1/8 W 1% 0805	RC0805	(2)
1	R39	120 Ohm	CR1206-JW-121ELF	RES MF 120 Ohm 1/4 W 5% 1206	RC1206	

Table 25: Bill of Materials ⁽¹⁾ (continued)

4	R42,R43,R44,R45	3.3 Ohm	RK73H1JTDD3R30F	RES MF 3.3 Ohm 1/10 W 1% 0603	RC0603	
1	R46	215 Ohm	CRCW2010215RFKEF	RES MF 215 Ohm 1/2 W 1%	RC2010	
1	R47	100 KOhm	CRCW0603100KJNEA	RES MF 100 K 1/10 W 5%	RC0603	
1	R48	1.0 KOhm	CRCW12061K00FKEA	RES MF 1.00 K 1/4 W 1% 1206	RC1206	
1	R49	100 KOhm	RK73H1JTDD1003F	RES MF 100 K 1/10 W 1% 0603	RC0603	
6	R57,R59,R60,R61, R63,R64	10 KOhm	CRCW060310K0FKEA	RES MF 10 K 1/10 W 1%	RC0603	
1	R68	1 KOhm	ERA3AEB102V	RES MF 1 K 1/10 W 0.1% 0603	RC0603	

Switches, Connectors, Jumpers and Test Points

1	SW1	SW_MOM	SKQYPDE010	SW SPST MOM PB 50 MA 12 V SMT	SMD	
7	TP1,TP2,TP3, TP4,TP5,TP6,TP7	TPAD_050		TEST POINT PAD 50MIL DIA (NOT A COMPONENT)	TPAD_050	
1	JP1	HDR 1X6	TSW-106-07-S-S	HDR 1X6 TH 100MIL SP 330 H	-	
1	J1	HDR_2X7	TSW-107-07-S-D	HDR 2X7 TH 100MIL CTR 330 H	-	
1	J2	CON_2X16 CON_2X12	12110209	32-pin CON 2X16 ASM RA TH 3 MM SP 27.5 MM 24-pin CON 2X12 ASM RA TH 3 MM SP 27.5 MM	-	
1	J3	CON_1_P WR	PJ-102AH	CON 1 PWR PLUG DIAM 2 MM	-	

Notes:

1. Freescale does not assume liability, endorse, or warrant components from external manufacturers that are referenced in circuit drawings or tables. While Freescale offers component recommendations in this configuration, it is the customer's responsibility to validate their application.
2. Do not populate.
3. **Critical components.** For critical components, it is vital to use the manufacturer listed.

10 References

Following are URLs where you can obtain information on related Freescale products and application solutions:

Freescale.com Support Pages	Description	URL
RDAIRBAGPSI5	Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=RDAIRBAGPSI5
MPC560xP	Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MPC560xP
MC33789	Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MC33789
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USBMLPPCNEXUS	Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=USBMLPPCNEXUS
CW-MCU10	CodeWarrior for MCUs	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=CW-MCU10
RDAIRBAGPSI5GUI	Freemaster Demonstrator GUI Project	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=RDAIRBAGPSI5&fpsp=1&tab=Design_Tools_Tab

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11 Revision History

Revision	Date	Description of Changes
1.0	8/2014	<ul style="list-style-type: none"> • Initial Release
2.0	10/2014	<ul style="list-style-type: none"> • Added kit contents for RDAIRBAGPSI5-1 • Updated Required Equipment section • Added Figure 12 (configuration diagram for the RDAIRBAGPSI5-1 kit using the wiring harness, and ECU cable connector)

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