

MPC560xB Controller Board User's Guide

by: Bretislav Zuczek
Automotive and Industrial Solutions Group

1 About This Book

This document describes the design of the MPC560xB Controller Board, which is targeted for rapid development of motor control applications.

To locate any published updates for this document, refer to the world-wide web at: <http://www.freescale.com/>.

2 Introduction

The MPC560xB Controller Board is designed to drive a 3-phase BLDC motor, enabling implementation of motor control techniques:

- Sensorless:
 - Back-EMF signal sensing using an MCU ATD converter module
 - Back-EMF zero-cross signal monitoring
- Sensor based:
 - Hall sensor signal monitoring

Contents

1	About This Book	1
2	Introduction	1
2.1	Features	2
2.2	MPC560xB Board Architecture	3
2.3	Board Jumper Configuration	4
2.4	Board LEDs	7
3	Interface Description	8
3.1	Power Supply J700	8
3.2	UNI3 Interface J800	9
3.3	MC33937A Interface J801	10
3.4	Hall Sensor Interface JP600	11
3.5	LIN Bus Connectors J702 & J703	11
3.6	MainCAN and AuxCAN connectors J701 & J900	12
3.7	USB Connectivity J300 & J301	12
3.8	Header J302	13
3.9	Header J303	13
3.10	Header J304	14
3.11	Headers J305 & J306 Analog Inputs	14
3.12	Header J307	16
3.13	Header J802	16
4	Design Consideration	17
4.1	MPC560xB Features	17
4.2	Power Supplies and Voltage Reference	20
4.3	Board Fault Management	20
4.4	Hall Sensor Interface	21
4.5	Analog Signal Sensing	23
4.6	UNI-3 PFC-PWM Signal (Power Factor Correction)	23
4.7	UNI-3 Brake Signal	23
4.8	MainCAN and AuxCAN Bus	24
4.9	LIN bus interfaces	24
5	Electrical Characteristics	24
6	Board Set-up Guide	24
	Appendix A References	26
	Appendix B Acronyms	26
	Appendix C MPC560xB Controller Board Schematic	27

Introduction

The on-board UNI-3 interface enables control of the BLDC motor power stage.

The LIN and CAN communication interfaces connect the board to the other automotive network nodes.

The USB interface is targeted at FreeMASTER PC-based application control.

The MPC560xB Controller Board can be assembled with other members of the MPC560xB microcontroller family. See [Table 1](#) for device compatibility.

Table 1. Device compatibility

Device	Functionality	Package	Note
MPC5604B	With restrictions	144LQFP	missing ADC1
MPC5605B	Complete	144LQFP	
MPC5606B	Complete	144LQFP	default assembled

2.1 Features

The MPC560xB Controller Board features are as follows:

- MPC560xB microcontroller, 144 LQFP package
- JTAG interface for MCU code download and debugging
- System-basis chip MC33905D
- Motor control interface:
 - UNI-3
 - MC33937A predriver
 - Hall sensors
- Connectivity interface:
 - 2 x LIN
 - 2 x CAN
 - USB interface
- LEDs:
 - Power-on indicators
 - Phase A, B, C PWM control signals
 - Phase A, B, C zero-cross
 - Hall sensor outputs
 - Faults monitoring
 - SBC safe mode
 - User application
 - Serial communication
- Controls:
 - Two general-purpose push buttons

- Two general-purpose switches
- Pin headers for MCU peripheral access.
- Power plug 2.1mm connector.

2.2 MPC560xB Board Architecture

The MPC560xB Controller Board contains the basic building blocks are depicted in Figure 1. The block color differentiates a block function:

- Blue — MCU and application software download, and the debug interface
- Green — Motor control related hardware
- Red — Board power supply and connectivity
- Violet — Application control

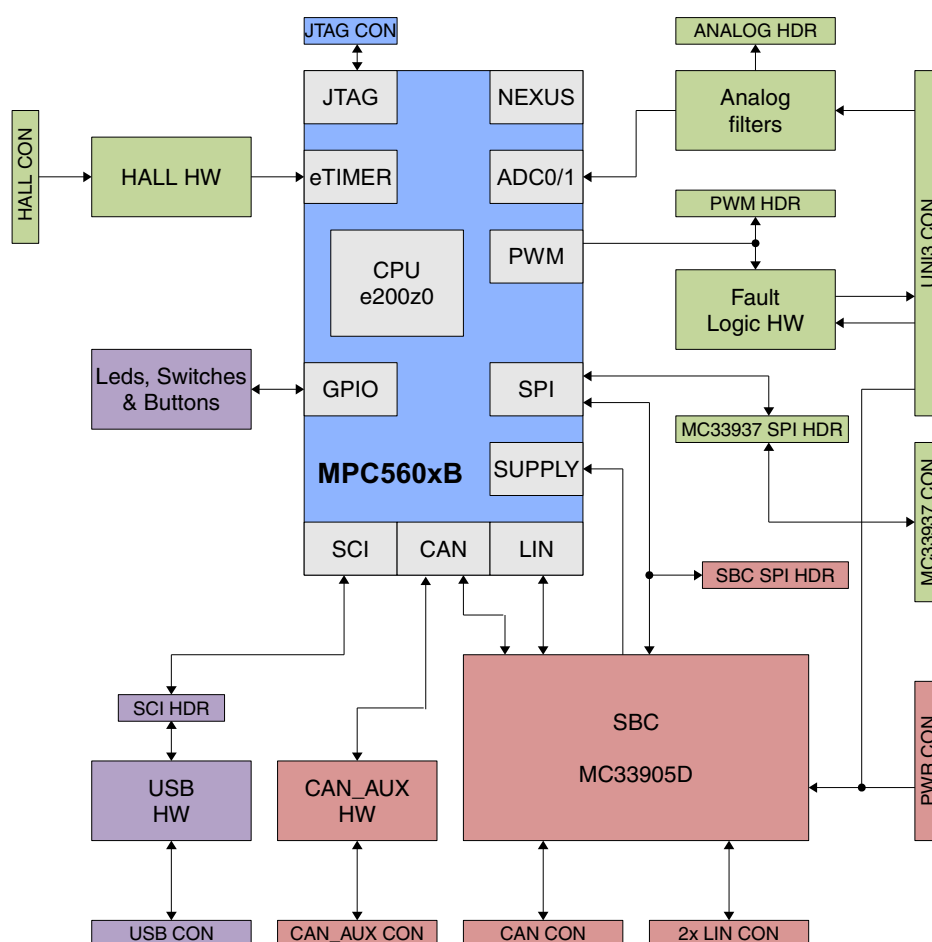


Figure 1. MPC560xB Controller Board Block Diagram

The board is supplied by VBAT voltage in the range of 8V to 18V. The MC33905 provides 5V to the HALL interface. The MCU and on-board logic are supplied by MCU_5V, depending on the assembled SBC version. The board is populated with the 5V SBC version by default.

Introduction

The MCU generates two PWM signals for each phase. The Fault logic triggers the DC-bus undervoltage and DC-bus overcurrent faults, and forces PWM signals to safe OFF states. For the circuitry behaviour, see [Section 4.3, “Board Fault Management](#).

The user can control the application using the push buttons and switches, USB interface (RS232), CAN and LIN buses.

The JTAG interface is present on-board to enable the download and debugging of MCU code.

For the on-board block location, see [Figure 2](#).

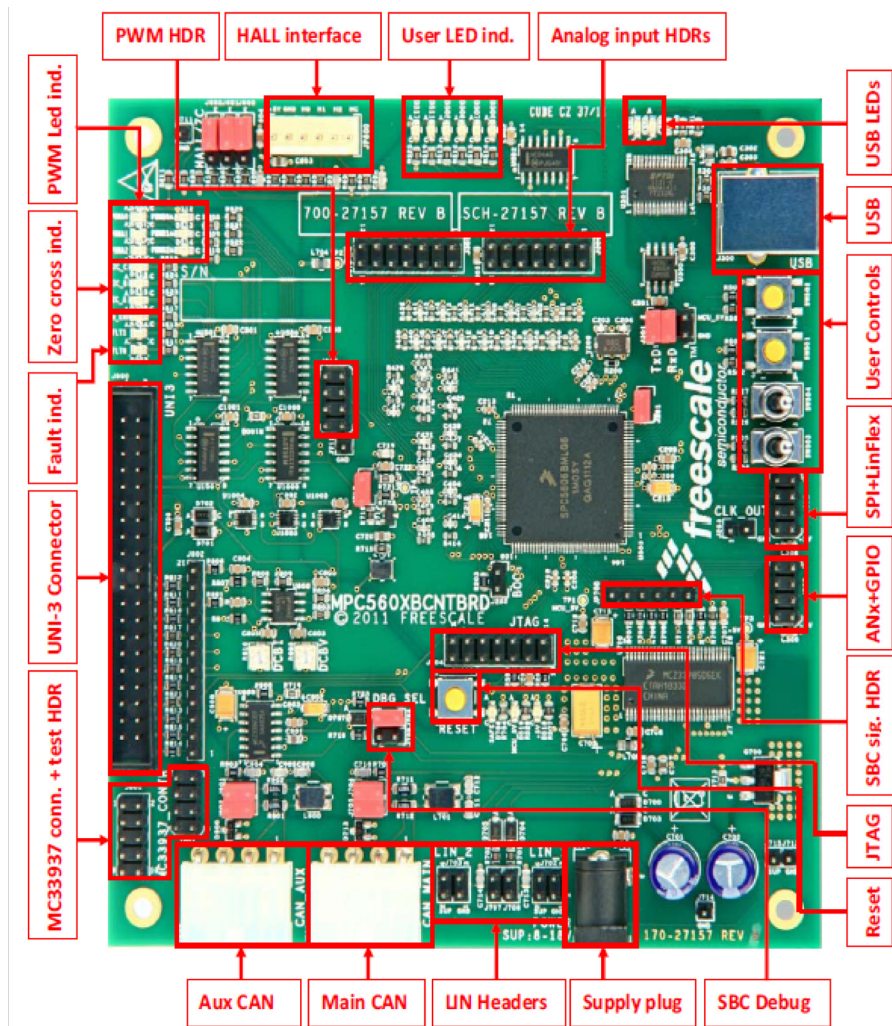


Figure 2. MPC560xB Controller Board Block Location

2.3 Board Jumper Configuration

See [Table 2](#) and [Figure 3](#) for proper jumper configuration.

Table 2. MPC560xB Board Configuration

Jumper	Selector	Function	Connections
J704 J705	MAIN CAN	MAIN CAN bus termination: - 120R, closed (default) - without termination, open	closed
J901 J902	AUX CAN	MAIN CAN bus termination: - 120R, closed (default) - without termination, open	closed
J706	LIN1	LIN_1 master / slave mode selection: - Master, closed - Slave, open (default)	open
J707	LIN2	LIN_2 master / slave mode selection: - Master, closed - Slave, open (default)	open
J708	MC33905D debug mode	Set MC33905D SBC to debug mode: - ON, closed (default) - OFF, open	closed
J709	MC33905D Fail-Safe mode	Set MC33905D SBC to Fail-Safe mode: - ON, closed - OFF, open (default)	open
J710	REF_JMP	Change reference supply voltage for ADCs: - 3.2 V closed (default) - 4.1 V open	closed
J201	EMIOS_JMP	External jumper to interconnect EMIOS0_CH7 and EMIOS1_CH25 signals	closed
J202	BOOT selection	MPC560xB boot from internal Flash.	open
J301	USB	LinFlex6 TxD & RxD connection to opto-isolated USB interface	1–2 closed 3–4 closed
J600	HALL0 / ZCA	HALL_0 input signal is connected to EMIOS0_CH8	1–2 open
		UNI-3 BEMFZCA input signal is connected to EMIOS0_CH8	2–3 closed
J601	HALL1 / ZCB	HALL_1 input signal is connected to EMIOS0_CH9	1–2 open
		UNI-3 BEMFZCB input signal is connected to EMIOS0_CH9	2–3 closed
J602	HALL2 / ZCC	HALL_2 input signal is connected to EMIOS0_CH10	1–2 open
		UNI-3 BEMFZCC input signal is connected to EMIOS0_CH10	2–3 closed
R811	DCBV Voltage	DC-bus Voltage signal from UNI-3 is connected to ADC01_P7	populated
R812	DCBI Current	DC-bus Current signal from UNI-3 is connected to ADC01_P8	populated
R813	BEMFA	UNI-3 Phase A Back-EMF Voltage is connected to ADC01_P4	populated
R814	BEMFB	UNI-3 Phase B Back-EMF Voltage is connected to ADC01_P5	populated
R815	BEMFC	UNI-3 Phase C Back-EMF Voltage is connected to ADC01_P6	populated

Table 2. MPC560xB Board Configuration (continued)

Jumper	Selector	Function	Connections
R816	TEMP	UNI-3 Temperature signal is connected to ADC01_P9	populated
R817	SERIAL	UNI-3 Serial signal is connected to GPIO A[12].	populated
R818	BRAKE	UNI-3 Brake output signal is connected to GPIO A[4].	populated
R819	PFC	UNI-3 PFC signal is connected to EMIOS1_CH0	populated
R820	PFC_EN	UNI-3 PFC Enable signal is connected to GPIO A[13]	populated
R821	PFC_ZC	UNI-3 PFC Zero current signal is connected to EMIOS1_CH1	populated

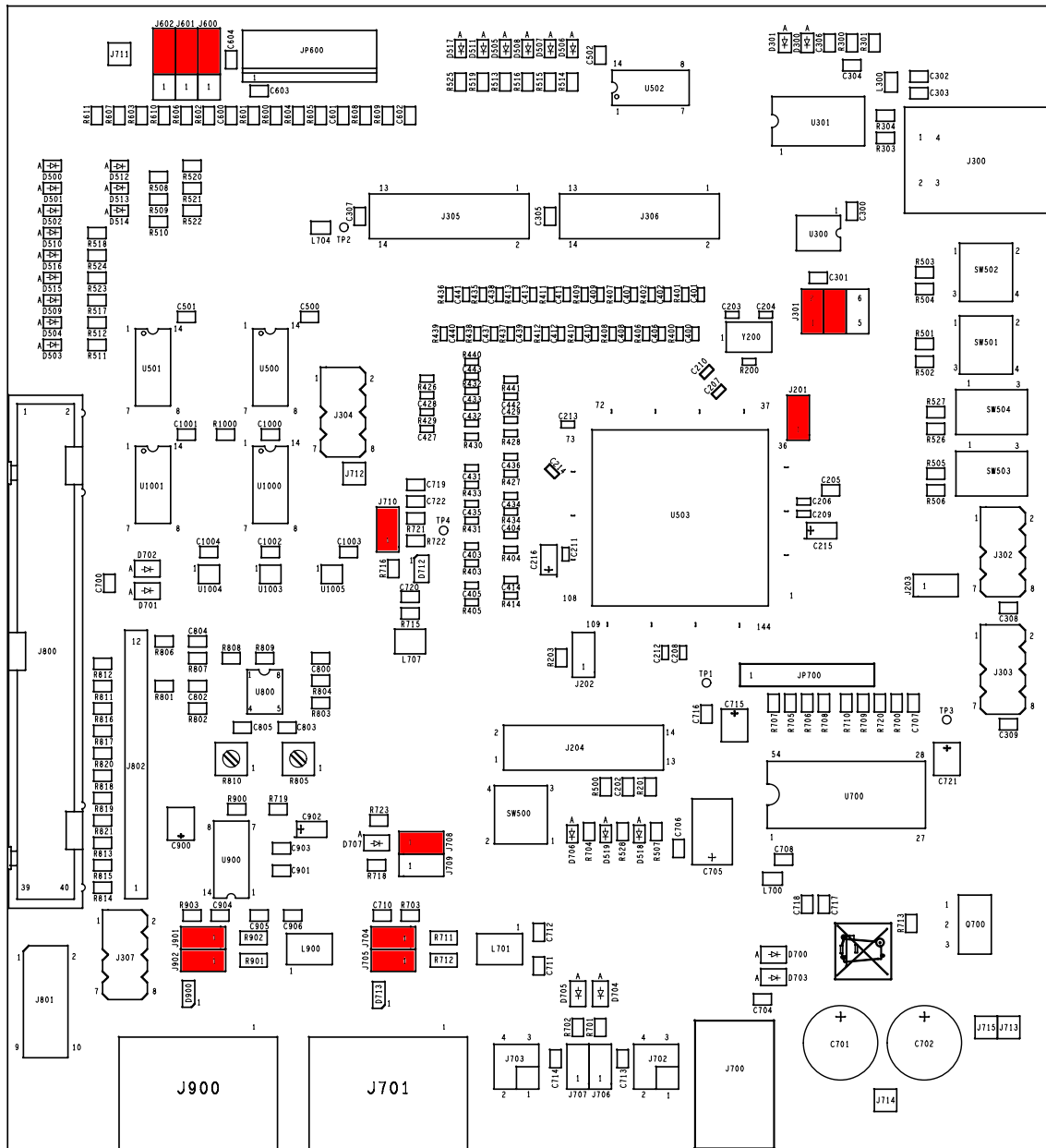


Figure 3. MPC560xB Controller Board Jumper Position and Default Setting

2.4 Board LEDs

The Table 3 displays the on-board LEDs. For on-board LED locations, see Figure 2.

Table 3. On-board LEDs

LED	Signal Name	Description
D518	MCU_5V	+5V MCU and peripheral power supply
D519	+5V	+5V auxiliary power supply
D706	/SAFE	MCZ33905 safe pin state (ON — SBC in safe mode)
D500	PWM0	Phase A0 top switch signal (ON — High Level)
D512	PWM1	Phase B0 bottom switch signal (ON — High Level)
D501	PWM2	Phase A1 top switch signal (ON — High Level)
D513	PWM3	Phase B1 bottom switch signal (ON — High Level)
D502	PWM4	Phase A2 top switch signal (ON — High Level)
D514	PWM5	Phase B2 bottom switch signal (ON — High Level)
D503	FAULT0	DC-bus undervoltage indicator
D504	FAULT1	DC-bus overcurrent indicator
D515	HALL0/ZCA	Hall 0 / Zero-cross Phase A signal (ON — High Level)
D516	HALL1/ZCB	Hall 1 / Zero-cross Phase B signal (ON — High Level)
D510	HALL2/ZCC	Hall 2 / Zero-cross Phase C signal (ON — High Level)
D509	G_ERR	General error indicator (ON — High Level)
D506	PB[0]	User LED 1 (ON — High Level)
D507	PC[10]	User LED 2 (ON — High Level)
D508	PC[11]	User LED 3 (ON — High Level)
D511	PF[9]	User LED 4 (ON — High Level)
D517	PF[8]	User LED 5 (ON — High Level)
D505	PB[1]	User LED 6 (ON — High Level)
D300	CBUS1	USB transmit data indicator
D301	CBUS0	USB receive data indicator

3 Interface Description

The following chapters summarize the on-board connectors and headers pin-outs, signal meanings and MCU pin assignments.

3.1 Power Supply J700

The MPC560xB Controller Board can be supplied either by using the 2.1 mm DC power plug J700 or the UNI-3 connector (J800, pin 19).

The controller board provides 5V for a Hall interface and 5V for on-board logic. Both voltages are generated by the MCZ33905D SBC. Proper operation is monitored by LEDs D518, for the supply voltage +5VDC & +5VA, and D519, for the supply voltage 5V_MCU, see [Table 3](#).

The board is designed to operate in the voltage range from 8V to 18V. The board is protected against a reverse battery.

3.2 UNI3 Interface J800

The Unified Interface Version 3 (UNI-3) defines the interface between the MPC560xB Motor Controller Board and the BLDC motor power stage.

The list of UNI-3 signals is as follows:

- Control signals:
 - PWM phase A, B, C top and bottom switches control
 - Brake signal control
 - Power Factor Correction (PFC)
- Monitor signals
 - DC-bus voltage
 - DC-bus current
 - Phase A, B, C current
 - Zero-cross signals
 - Back-EMF phase A, B, C
 - Temperature monitoring
- Power Supply 12V
- Serial line — a bidirectional communication line between the Controller Board and Power Stage

The [Table 4](#) defines the UNI-3 pin-out and pin assignment to the MCU.

Table 4. UNI-3 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	PWM0	EMIOS0_CH[1]	Phase A top switch control (H -> Turn OFF)	Digital output
3	PWM1	EMIOS0_CH[2]	Phase A bottom switch control (H -> Turn ON)	Digital output
5	PWM2	EMIOS0_CH[3]	Phase B top switch control (H -> Turn OFF)	Digital output
7	PWM3	EMIOS0_CH[4]	Phase B bottom switch control (H -> Turn ON)	Digital output
9	PWM4	EMIOS0_CH[5]	Phase C top switch control (H -> Turn OFF)	Digital output
11	PWM5	EMIOS0_CH[6]	Phase C bottom switch control (H -> Turn ON)	Digital output
2, 4, 6, 8, 10	Shield	—	PWM signals shield (grounded on the power stage side only)	—
12,13	GND_D	—	Digital power supply ground	—
14, 15	+5V DC	—	+5V digital power supply	—
17, 18	AGND	—	Analogue power supply ground	—
19	+12/+15V DC	—	Analogue power supply	—
16,20, 23,24,25, 27, 28,37	NC	—	Not connected	—

Table 4. UNI-3 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
21	V _{DCBUS}	ADC0/1_P[7]	DC-bus voltage sensing, 0V – 3.3V	Analog input
22	I _{DCBUS}	ADC0/1_P[8]	DC-bus current sensing, 0V – 3.3V	Analog input
26	TEMP	ADC0/1_P[9]	Analogue temperature 0V – 3.3V	Analog input
29	BRAKE_CONT	PA[4]	DC-bus brake control	Digital output
30	SERIAL	PA[12]	Serial interface	Digital bidirectional
31	PFC	EMIOS1_CH[0]	Power factor correction PWM	Digital output
32	PFCEN	PA[13]	Power factor correction enable	Digital output
33	PFCZC	EMIOS1_CH[1]	Power factor correction zero-cross	Digital input
34	ZCA	EMIOS0_CH[12]	Phase A Back-EMF zero-cross	Digital input
35	ZCB	EMIOS0_CH[14]	Phase B Back-EMF zero-cross	Digital input
36	ZCC	EMIOS0_CH[15]	Phase C Back-EMF zero-cross	Digital input
38	Back-EMF_A	ADC0/1_P[4]	Phase A Back-EMF voltage sensing	Analog input
39	Back-EMF_B	ADC0/1_P[5]	Phase B Back-EMF voltage sensing	Analog input
40	Back-EMF_C	ADC0/1_P[6]	Phase C Back-EMF voltage sensing	Analog input

3.3 MC33937A Interface J801

When using a Freescale 3-phase Low-Voltage Power Stage [1], the phase top and bottom switches are controlled by the MC33937A pre-driver. The device is configured by the SPI, see [Table 5](#).

Table 5. MC33937A Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	NC	—	Not connected.	—
2	NC	—	Not connected	—
3	MC33937_EN	PA[14]	Device enable	Digital output
4	MC33937_OC	PF[11]	Overcurrent	Digital input
5	MC33937_/RST	PF[10]	Reset	Digital output
6	MC33937_INT	PF[13]	Interrupt	Digital input
7	MC33937_SOUT	DSPI[4]_SIN	SPI Input data	Digital input
8	MC33937_SCK	DSPI[4]_SCLK	SPI clock	Digital output
9	MC33937_CS	DSPI[4]_CS0	Chip-select	Digital output
10	MC33937_SIN	DSPI[4]_SOUT	SPI output data	Digital output

3.4 Hall Sensor Interface JP600

When developing the sensor based BLDC application, the Hall sensors are used to determine the actual motor rotor sector. Connect the motor Hall sensors outputs to JP600 following the instructions in [Table 6](#), and watch the signal levels on the on-board LEDs as in [Table 2](#), [Table 3](#).

Table 6. Hall Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	+5Vdc	—	+5V sensor supply voltage	—
2	GND	—	Ground	—
3	HALL0	EMIOS0_CH[12]	HALL0 sensor output	Digital input
4	HALL1	EMIOS0_CH[14]	HALL1 sensor output	Digital input
5	HALL2	EMIOS0_CH[15]	HALL 2 sensor output	Digital input
6	NC	—	Not connected	—

3.5 LIN Bus Connectors J702 & J703

The system basis chip MC33905D LIN transceiver is used as an on-board LIN interface hardware. The LIN node can be configured to either the Master or Slave mode, see [Table 2](#).

[Table 7](#) and [Table 8](#) show the LIN connector's pin-out and pin assignment to the MCU.

Table 7. LIN_1 J702 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	GND	—	Ground	—
2	VSUP	—	Power Supply	—
3	GND	—	Ground	—
4	LIN	LIN[4]RX LIN[4]TX	LIN bus	Digital bidirectional

Table 8. LIN_2 J703 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	GND	—	Ground	—
2	VSUP	—	Power Supply	—
3	GND	—	Ground	—
4	LIN	LIN[0]RX LIN[0]TX	LIN bus	Digital bidirectional

3.6 MainCAN and AuxCAN connectors J701 & J900

The system basis chip MC33905D CAN transceiver is used as the main CAN hardware interface. The on-board jumpers J704, J705 enable node termination, with impedance of 120R, see [Table 2](#).

An auxiliary CAN interface is provided by the MC33902 transceiver. The on-board jumpers J900, J901 enable node termination, with impedance of 120R, see [Table 2](#).

[Table 9](#) and [Table 10](#) show the CAN connector’s pin-out and pin assignment to the MCU.

Table 9. MainCAN J701 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	CANH	CAN[4]RX CAN[4]TX	CAN bus H	Differential bidirectional
2	CANL	CAN[4]RX CAN[4]TX	CAN bus L	Differential bidirectional
3	GND	—	Ground	—
4	NC	—	Not connected	—

Table 10. AuxCAN J900 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	CANH	CAN[1]RX CAN[1]TX	CAN bus H	Differential bidirectional
2	CANL	CAN[1]RX CAN[1]TX	CAN bus L	Differential bidirectional
3	GND	—	Ground	—
4	NC	—	Not connected	—

3.7 USB Connectivity J300 & J301

The USB line is used for board communication with the PC, when using for example, the Freescale FreeMASTER tool [3] to control the user application. The interface uses a B-type connector and it is isolated from the board environment. See [Table 11](#) for the pin description and pin assignment to the MCU.

Header J301 enables USB communication or can be used for LINFlex_6 signals and power supply pins access. For more details see [Table 12](#).

Table 11. J300 USB Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	VBUS	—	USB Power Supply	—
2	D-	LIN[6]RX LIN[6]TX	Data –	Digital bidirectional

Interface Pin	Signal Name	MCU Signal	Description	Direction
3	D+	LIN[6]RX LIN[6]TX	Data +	Digital bidirectional
4	GND_USB	—	USB Ground	—

Table 12. J301 USB communication enable

Header pins	Jumper settings	Description
1+2	On (default)	Enable SCI transmit
	Off	Disable SCI transmit
3+4	On (default)	Enable SCI receive
	Off	Disable SCI receive
5	GND	Power Supply Ground
6	MCU_5V	Power Supply MCU_5V

NOTE

Pay attention to not short out pins 5 and 6.

3.8 Header J302

The connectivity expansion header J302 contains the LINFlex_7 and DSPI_3 signals, see [Table 13](#).

Table 13. J302 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	HDR_LINFL_RX	LIN[7]_RX	LINFlex Receive Data	Digital input
2	HDR_LINFL_TX	LIN[7]_TX	LINFlex Transmit Data	Digital output
3	HDR_SPI_CS0	DSPI[3]_CS0	Serial Peripheral Interface Chip Select	Digital output
4	HDR_SPI_SOUT	DSPI[3]_SOUT	Serial Peripheral Interface Output	Digital output
5	HDR_SPI_SIN	DSPI[3]_SIN	Serial Peripheral Interface Input	Digital input
6	HDR_SPI_SCK	DSPI[3]_SCK	Serial Peripheral Interface Clock	Digital output
7	GND	—	Ground	
8	+5VDC	—	+5V Digital Power Supply	

3.9 Header J303

Header J303 is primarily dedicated to connecting the external analogue multiplexer hardware which allows expansion of up to 8 additional ADC channels. For multiplexer channels decoding, MA[x] signals are used. Multiplexed channels are connected to the ADC0_X[3] input. In other cases, the header J303 pins can be used as general purpose I/O. See a detailed description in [Table 14](#).

Table 14. J303 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	HRD_PH[8]_MA0	PH[8]/MA[0]	General purpose pin / External MPX channel decoder	Digital I/O
2	HRD_PH[7]_MA1	PH[7]/MA[1]	General purpose pin / External MPX channel decoder	Digital I/O
3	HRD_PH[6]_MA2	PH[6]/MA[2]	General purpose pin / External MPX channel decoder	Digital I/O
4	HRD_PH[5]	PH[5]	General purpose pin	Digital I/O
5	HRD_PH[4]	PH[4]	General purpose pin	Digital I/O
6	HRD_ANX[3]	PB[15]/ADC0_X[3]	Externally multiplexed analogue input	IO / Analog input
7	GND	—	Ground	
8	+5VDC	—	+5V Digital Power Supply	

3.10 Header J304

Monitoring the PWM signal and FAULT signal is possible using J304. The [Table 15](#) summarizes the header pin-out.

Table 15. J304 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	PWM_AT	EMIOS0_CH[1]	Phase A top switch control	Digital output
2	PWM_AB	EMIOS0_CH[2]	Phase A bottom switch control	Digital output
3	PWM_BT	EMIOS0_CH[3]	Phase B top switch control	Digital output
4	PWM_BB	EMIOS0_CH[4]	Phase B bottom switch control	Digital output
5	PWM_CT	EMIOS0_CH[5]	Phase C top switch control	Digital output
6	PWM_CB	EMIOS0_CH[6]	Phase C bottom switch control	Digital output
7	FAULT0	EIRQ[18]	DC-bus Voltage fault signal	Digital input
8	FAULT1	EIRQ[7]	BC-bus Current fault signal	Digital input

3.11 Headers J305 & J306 Analog Inputs

The MPC560xB includes 2 ADC modules, ADC_0 with 10-bit resolution and ADC_1 with 12-bit resolution with $0 \div V_{ref}$ common mode conversion range, see [Section 4.2, “Power Supplies and Voltage Reference.”](#) Both ADCs are supplied from the voltage reference.

- Internally multiplexed channels
 - 16 precision channels shared between 10-bit and 12-bit ADCs
 - 3 standard channels shared between 10-bit and 12-bit ADCs
 - 5 dedicated standard channels on 12-bit ADC
 - Up to 29 dedicated standard channels on 10-bit ADC

- Externally multiplexed channels
 - Internal control to support generation of external analogue multiplexer selection
 - 4 internal channels optionally used to support externally multiplexed inputs, providing transparent control for additional ADC channels
 - Each of the 4 channels supports as many as 8 externally multiplexed inputs (ANX3 available on the controller board only)

External analogue signals can be connected through headers J305, J306, see [Table 16](#) and [Table 17](#).

Table 16. J305 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	AN0_S	PA[14]	Standard channel (ADC0/ADC1)	Analog input
2	AN1_S	PF[10]	Standard channel (ADC0/ADC1)	Analog input
3	AN2_S	PF[11]	Standard channel (ADC0/ADC1)	Analog input
4	AN3_P	PF[13]	Precision channel (ADC0/ADC1)	Analog input
5	AN4_P	DSPI[4]_SCK	Precision channel (ADC0/ADC1)	Analog input
6	AN5_P	DSPI[4]_SIN	Precision channel (ADC0/ADC1)	Analog input
7	AN6_P	DSPI[4]_SOUT	Precision channel (ADC0/ADC1)	Analog input
8	AN7_P	DSPI[4]_CS	Precision channel (ADC0/ADC1)	Analog input
9	AN8_P		Precision channel (ADC0/ADC1)	Analog input
10	AN9_P		Precision channel (ADC0/ADC1)	Analog input
11	AN10_P		Precision channel (ADC0/ADC1)	Analog input
12	AN11_P		Precision channel (ADC0/ADC1)	Analog input
13	GNDA		Ground	–
14	+5VA		+5V analog supply voltage	–

Table 17. J306 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	ANA0	PA[14]	Standard channel (ADC0)	Analog input
2	ANA1	PF[10]	Standard channel (ADC0)	Analog input
3	ANA2	PF[11]	Standard channel (ADC0)	Analog input
4	ANA3	PF[13]	Standard channel (ADC0)	Analog input
5	ANA4	DSPI[4]_SCK	Standard channel (ADC0)	Analog input
6	ANA5	DSPI[4]_SIN	Standard channel (ADC0)	Analog input
7	ANA6	DSPI[4]_SOUT	Standard channel (ADC0)	Analog input
8	ANA7	DSPI[4]_CS	Standard channel (ADC0)	Analog input
9	ANA8		Standard channel (ADC0)	Analog input

Interface Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
10	ANA9		Standard channel (ADC0)	Analog input
11	ANA10		Standard channel (ADC0)	Analog input
12	NC		Not connected	Analog input
13	GNDA		Ground	–
14	+5VA		+5V analogue supply voltage	–

3.12 Header J307

Header J307 allows control signals monitoring of the MC33937A, see [Table 18](#).

Table 18. J307 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	MC33937_EN	PA[14]	MC33937 Device Enable	Digital output
2	MC33937_RST	PF[10]	MC33937 Device Reset	Digital output
3	MC33937_OC	PF[11]	MC33937 Overcurrent indication	Digital input
4	MC33937_INT	PF[13]	MC33937 Interrupt	Digital input
5	MC33937_SCK	DSPI[4]_SCK	MC33937 Serial Peripheral Interface Clock	Digital output
6	MC33937_SIN	DSPI[4]_SIN	MC33937 Serial Peripheral Interface Input	Digital output
7	MC33937_SOUT	DSPI[4]_SOUT	MC33937 Serial Peripheral Interface Output	Digital input
8	MC33937_CS	DSPI[4]_CS	MC33937 Serial Peripheral Interface Chip Select	Digital output

3.13 Header J802

Header J802 is usable for external measurement and monitoring of UNI3 signals, important for the motor control application, see [Table 19](#).

Table 19. J802 Signal Description

Interface Pin	Signal Name	MCU Signal	Description	Direction
1	BEMFB	—	Phase B Back-EMF voltage	
2	BEMFC	—	Phase C Back-EMF voltage	
3	BEMFA	—	Phase A Back-EMF voltage	
4	PFCZC	—	Power factor correction Zero-cross	
5	PFC	—	Power factor correction PWM	
6	BRAKE	—	DC-bus brake control signal	
7	PFCEN	—	Power factor correction enable signal	
8	SERIAL	—	Serial interface	
9	TEMP	—	MC33937A Temperature	

Interface Pin	Signal Name	MCU Signal	Description	Direction
10	DCBV	—	DC-bus voltage	
	DCBI	—	DB-bus current	
	GND	—	Ground	

4 Design Consideration

This chapter provides additional information on the functional blocks of the MPC560xB Motor controller board.

4.1 MPC560xB Features

The Qorivva MPC560xB family of 32-bit microcontrollers is the latest achievement in integrated automotive body application controllers. It belongs to an expanding family of automotive-focused products designed to address the next wave of body electronics applications within the vehicle. The advanced and cost-efficient host processor core of the MPC560xB 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.

The availability of up to two Enhanced Modular Input/Output Subsystem modules (eMIOS) with enhanced timer capabilities, up to two Analogue-to-Digital Converters (ADC) modules, and a Cross Triggering Unit (CTU) makes the MPC560xB microcontrollers suitable for BLDC motor control applications.

Table 20. Supported MPC560xB device comparison(144 LQFP package)

Feature	Device		
	MPC5604B	MPC5605B	MPC5606B
CPU	e200z0h		
Execution speed	Up to 64MHz		
Code Flash	512 KB	768 KB	1 MB
Data Flash	64 KB		
RAM	48 KB	64 KB	80 KB
eMIOS_0	28 ch, 16-bit	32 ch, 16-bit	
eMIOS_1	28 ch, 16-bit	32 ch, 16-bit	
ADC_0	36 ch, 10-bit	15 ch, 19 ch shared, 10-bit	15 ch, 19 ch shared, 10-bit
ADC_1	No	5 ch, 19 ch shared, 12-bit	5 ch, 19 ch shared, 12-bit
CTU	Yes		
eDMA	No	16 channel	
SCI (LINFlex)	4	6	

Table 20. Supported MPC560xB device comparison(144 LQFP package)

Feature	Device		
	MPC5604B	MPC5605B	MPC5606B
SPI (DSPI)	3	5	
IIC	1		
CAN (FlexCAN)	6		
Debug	JTAG		

The device block diagram is shown in [Figure 4](#). A detailed description of the MCU can be found in the datasheet or reference manual.

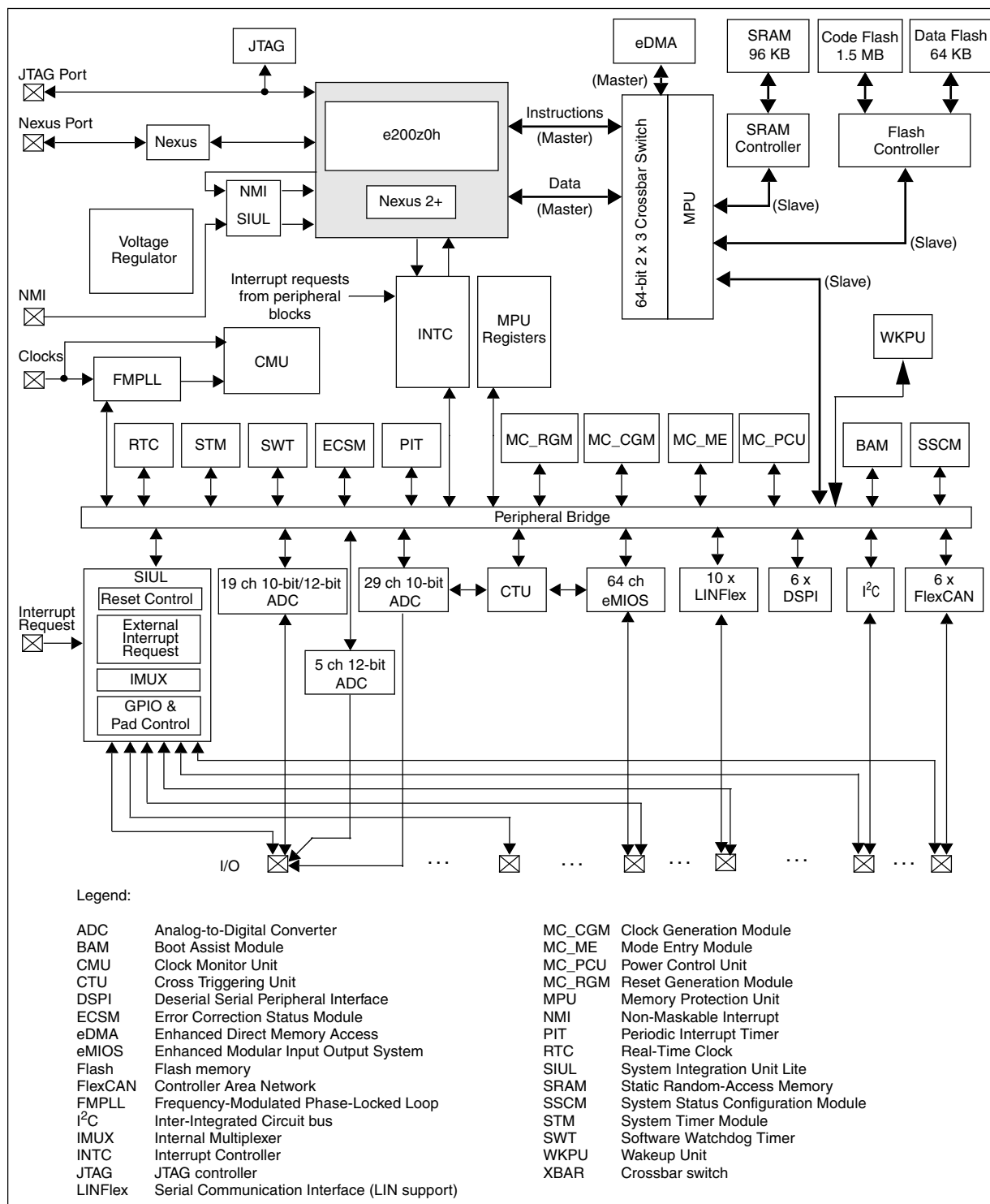
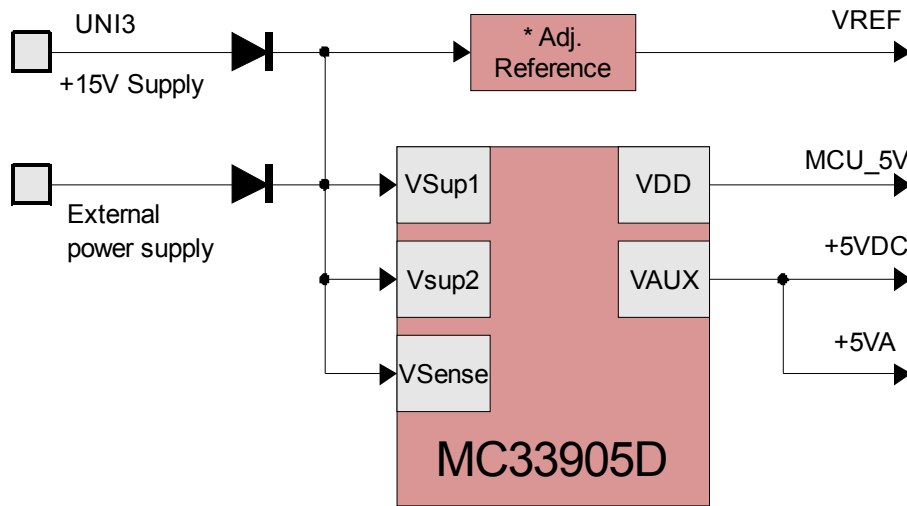


Figure 4. MPC5607B Family Block Diagram

4.2 Power Supplies and Voltage Reference

The MPC560xB Controller Board can be supplied from two main power supply inputs. The first one uses a 2.1 mm DC power plug and the second one uses the UNI-3 connector. Which one is more suitable depends on the application type. The controller board provides a +5V DC-voltage regulation for the HALL sensor interface, LED indicators and a fault logic circuit, MCU_5V for MCU + supporting logic, +5VA to supply external analogue modules and to provide the reference voltage for the ADC module. Power applied to the MPC560xB Controller Board is indicated by a power-on LED. The block diagram is shown in Figure 5.



* Note: Default value of Voltage reference is 3.2V

Figure 5. Power supply

4.3 Board Fault Management

Faults can be processed either by MCU software or by the on-board hardware.

To detect error states very quickly, the MPC560xB Controller Board provides two adjustable comparators and a fault logic circuit to force a disconnection of PWM signals from the MCU. The FAULT0 signal indicates an undervoltage state on DC-bus. The error level can be adjusted by trimmer R805. The FAULT1 signal indicates an overcurrent state on DC-bus and the error level can be adjusted by trimmer R810. The fault logic circuit is enabled by default and can be disabled by setting MCU port pin A[15] low. Before starting the motor control application, the fault logic circuit must be set to the default state by generating a positive pulse on the FLT_RESET signal (MCU port pin G[0]). The working principle can be seen in Figure 6.

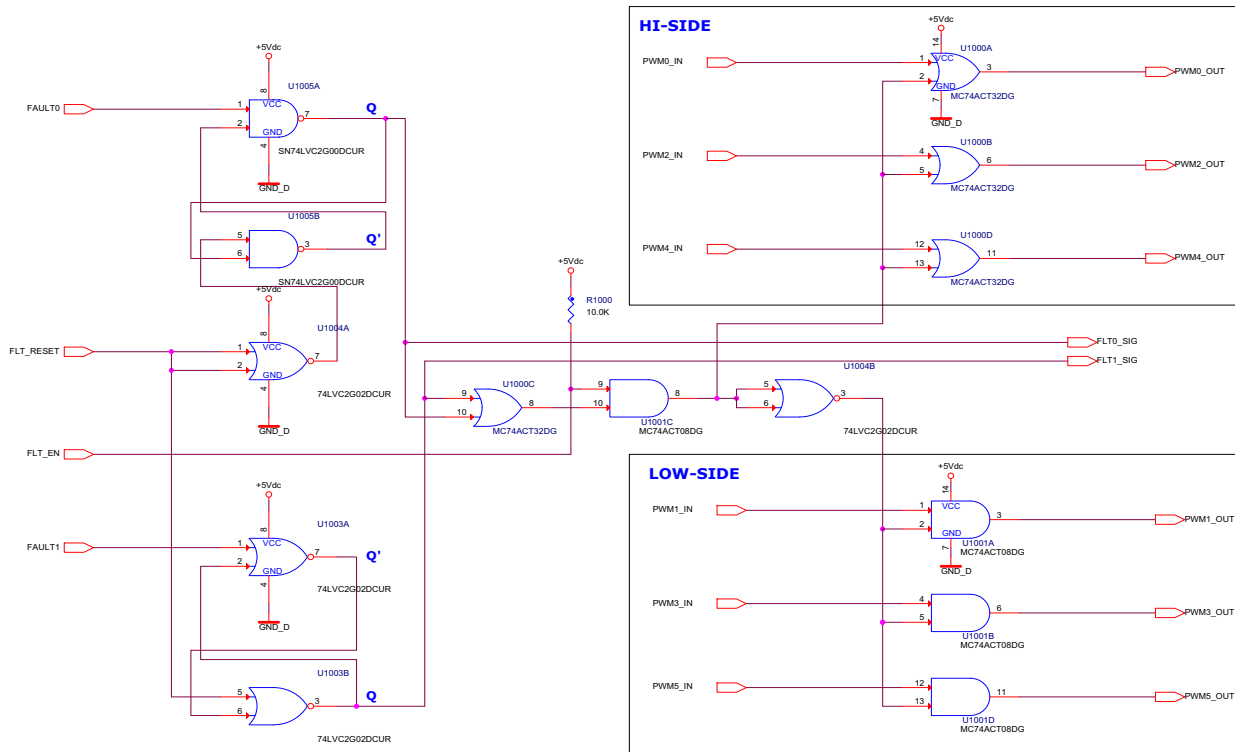


Figure 6. Fault Management Hardware

4.4 Hall Sensor Interface

The Hall sensor interface is used for the BLDC sensor based motor control application. The Hall sensors are used to determine the actual motor rotor sector.

The on-board interface provides the 5V power supply voltage to supply the sensors. The Hall interface inputs are designed to support an open collector as well as push-pull Hall sensors outputs, see [Figure 7](#). A single pole RC low-pass filter is present to reduce the signal noise.

For a detailed JP600 connector signal description, see [Table 6](#).

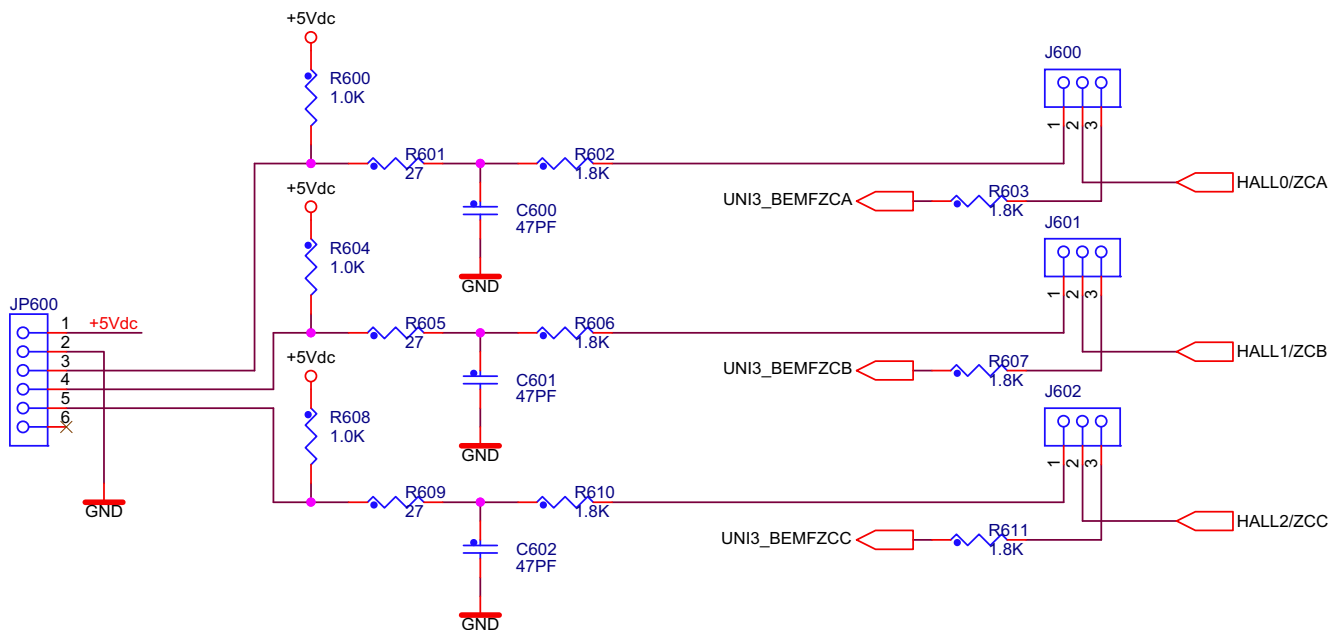


Figure 7. Hall Sensor Interface

The Figure 8 shows the Hall sensor signal alignment to the BLDC motor Back-EMF signal. The Hall sensors detect the rotor flux, so their actual state is not influenced by stator current. The Hall effect outputs in BLDC motors divide the electrical revolution into three equal sections of 120°. In this so-called 120° configuration, the Hall states 111 and 000 never occur.

Based on the Hall sensor signal, the BLDC motor commutation table is developed. An example is shown in Figure 9. The right-hand side of the table shows the Hall sensors signal, while the left side the applied phase voltage.

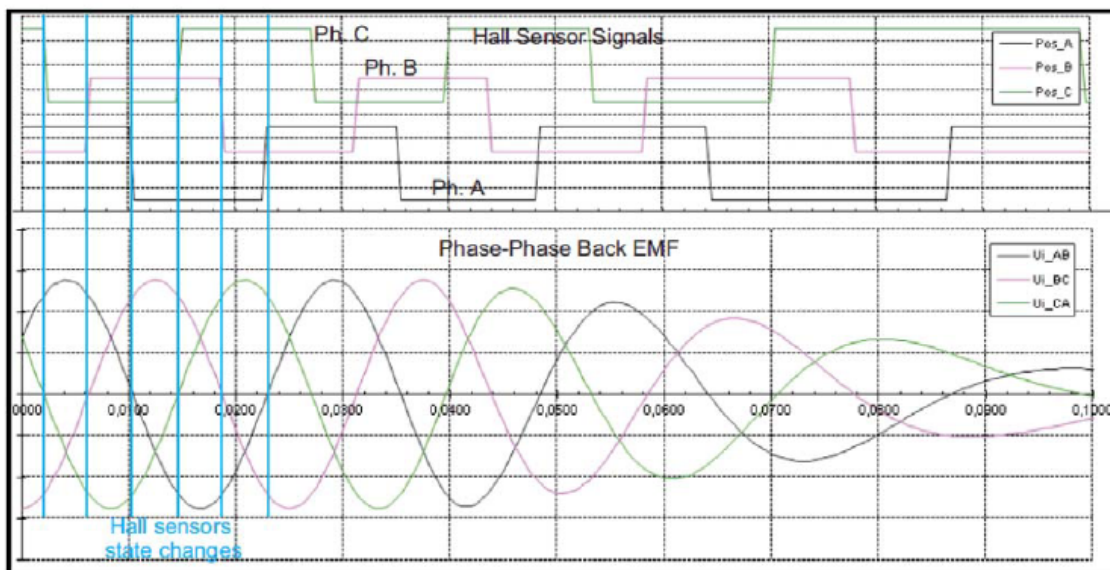


Figure 8. BLDC Motor Back-EMF and Hall Sensor Signal Alignment

Commutation vector			Vector	Hall sensor pattern definition			Hall sensor pattern result
Phase A	Phase B	Phase C		Hall Sensor C	Hall Sensor B	Hall Sensor A	
NC	+V _{DCB}	-V _{DCB}	A	1	0	1	5
-V _{DCB}	+V _{DCB}	NC	B	1	0	0	4
-V _{DCB}	NC	+V _{DCB}	C	1	1	0	6
NC	-V _{DCB}	+V _{DCB}	D	0	1	0	3
+V _{DCB}	-V _{DCB}	NC	E	0	1	1	2
+V _{DCB}	NC	-V _{DCB}	F	0	0	1	1

Figure 9. Example of BLDC Motor Commutation

4.5 Analog Signal Sensing

The analog input signals listed in [Figure 10](#), [Table 16](#), and [Table 17](#) are connected to the analogue to digital converters through the RC filters. The time constant of RC filter is set with respect to the input signal bandwidth.

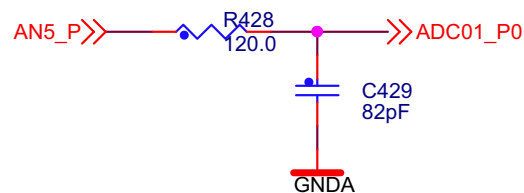


Figure 10. Analog Sensing Circuit

4.6 UNI-3 PFC-PWM Signal (Power Factor Correction)

The PFC-PWM signal is used to control a power stage circuit such as a PFC or a power DC-DC converter (when available). These signals are connected to the MPC560xB controller. For more details, see [Table 21](#).

Table 21. UNI-3 PFC-PWM Signals

Signal	MPC5606B signal	UNI-3 pin
PFC-PWM	EMIOS1_CH0	31
PFC_ENABLE	GPIO A[13]	32
PFC_ZERO_CROSS	EMIOS1_CH1	33

4.7 UNI-3 Brake Signal

The brake signal output is used to control the DC-bus resistor switch. It is controlled via GPIO A[4].

4.8 MainCAN and AuxCAN Bus

The FlexCAN module is a communication controller implementing the CAN protocol according to the CAN 2.0B protocol specification, which supports both standard and extended message frames. A number of Message Buffers (32) is also supported. Please refer to the MPC560xB reference manual for a detailed description. The Freescale system basis chip MCZ33905D with one CAN is used as the main CAN hardware interface, and the Freescale chip MCZ33902 is used as the auxiliary hardware interface. Jumpers (J704, J705) and (J900, J901) define the middle or end node.

4.9 LIN bus interfaces

The LINFlex (Local Interconnect Network Flexible) controller interfaces the LIN network and supports the LIN protocol versions 1.3, 2.0 and 2.1, and J2602 in both Master and Slave modes. Please refer to the MPC560xB reference manual for a detailed description. The Freescale system basis chip MC33905D, with two LIN bus physical interfaces, provides an additional possibility for connection. Both the LIN_1 and LIN_2 interfaces can be configured as master or slave by jumpers (J706, J707).

5 Electrical Characteristics

The electrical characteristics in [Table 22](#) apply to an operation at 25 °C.

Table 22. Electrical Characteristics

Characteristic	Symbol	Min	Typ	Max	Units
Power supply Voltage	V_{DC}	8	12	18	V
Current consumption ⁽¹⁾	I_{CC}		40		mA
Input Voltage Range	V_{IN}	0	—	5	V
Input Voltage Range Hall and MC33937 interface	V_{IN}	0	—	5	V

¹—12V power supply, MCU without software

6 Board Set-up Guide

The board is designed to be supplied either by the UNI-3 interface or by using the on-board J700 connector, with a power supply voltage from 8 to 18V. When using the board as a stand-alone EVB, connect the power supply to J700. In the case of board operation with the power stage, it is recommended to supply the board using the UNI-3 interface.

The MPC560xB Controller Board is designed for operation with the Freescale MC33937A based 3-Phase low-voltage power stage; see [Figure 11](#). The complete 3-phase BLDC Sensor / Sensorless Development Kit can be ordered at <http://www.freescale.com/AutoMCDevKits>.

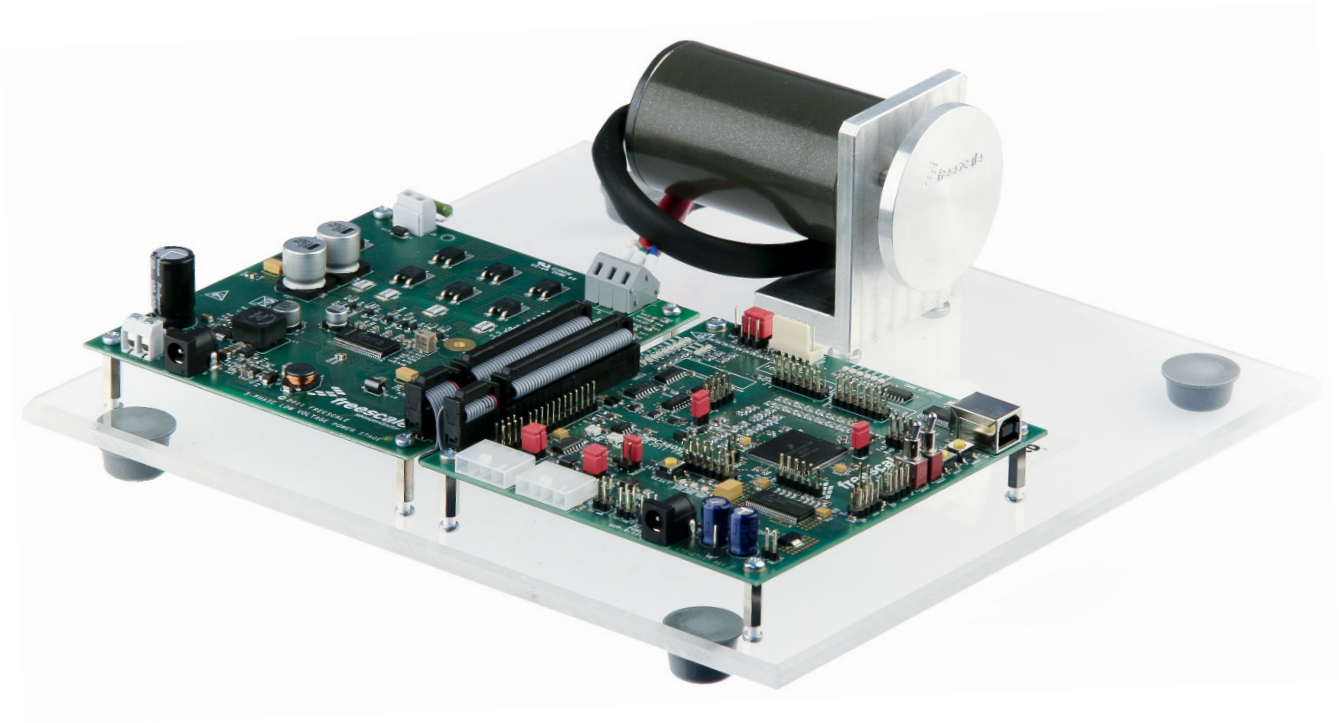


Figure 11. 3-Phase BLDC Sensor / Sensorless Development Kit

Appendix A References

1. 3-phase Low-Voltage Power Stage, www.freescale.com/AutoMCDevKits
2. MPC5607B Family Reference Manual, MPC5607BRM Rev. 7.1, 6 June 2011
3. FreeMASTER Run-time Debugging Tool, www.freescale.com/FREEMASTER
4. MPC560xB documentation is available at the Freescale website www.freescale.com

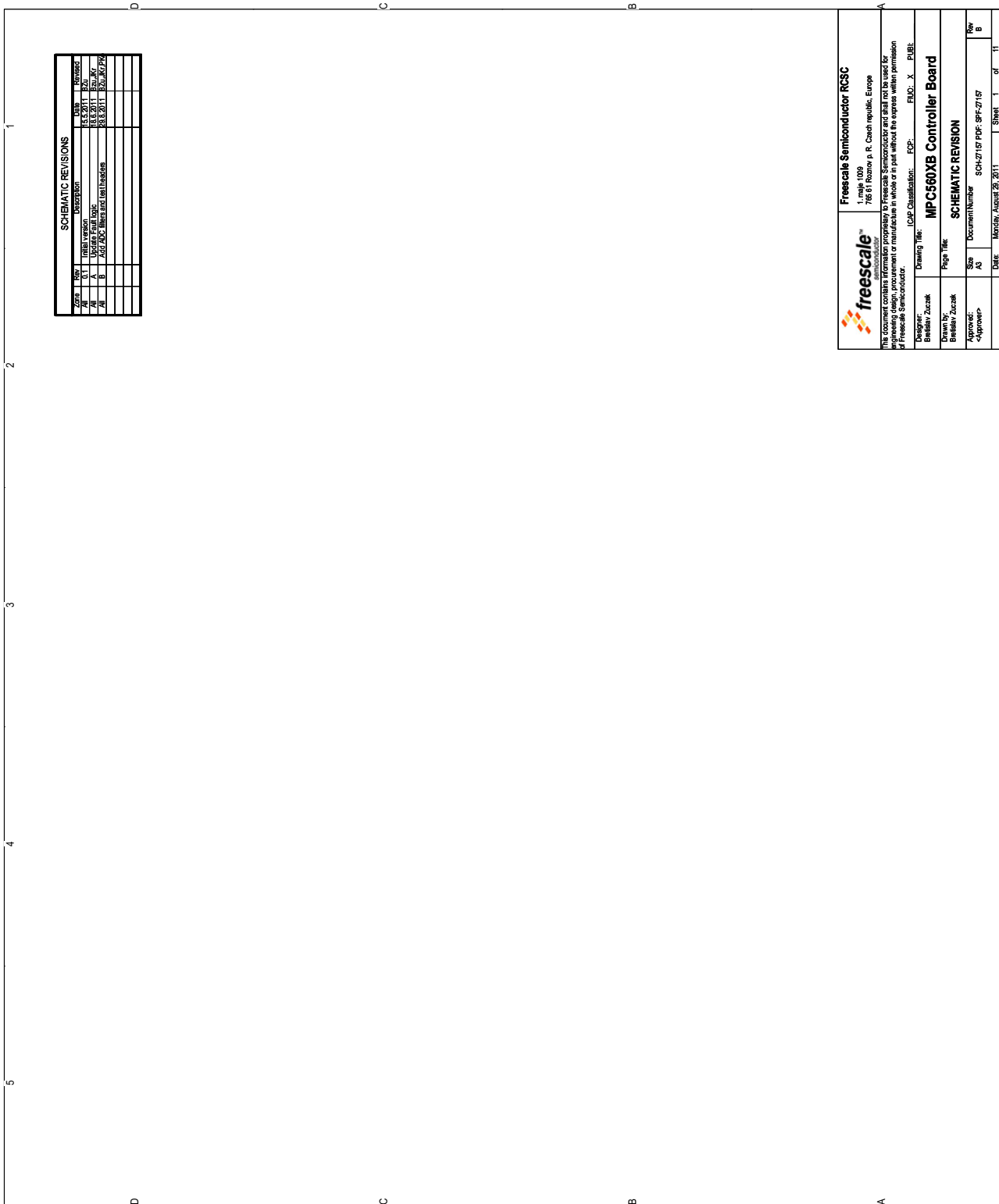
Appendix B Acronyms

Table 23. Acronyms

Acronyms	Description
ADC	Analog to Digital Converter
BEMF	Back Electromotive Force
BLDC	Brushless DC Motor
CAN	Controller Area Network
LIN	Local Interconnect Network
MCU	Microcontroller Unit
PC	Personal Computer
PWM	Pulse Width Modulation
SBC	System Basis Chip
EVB	Evaluation Board
USB	Universal Serial Bus

Appendix C MPC560xB Controller Board Schematic

MPC560xB Controller Board Schematic



freescale™ Freescale Semiconductor RCSC
 1, rue de la Libération
 78651 Rocquencourt, France

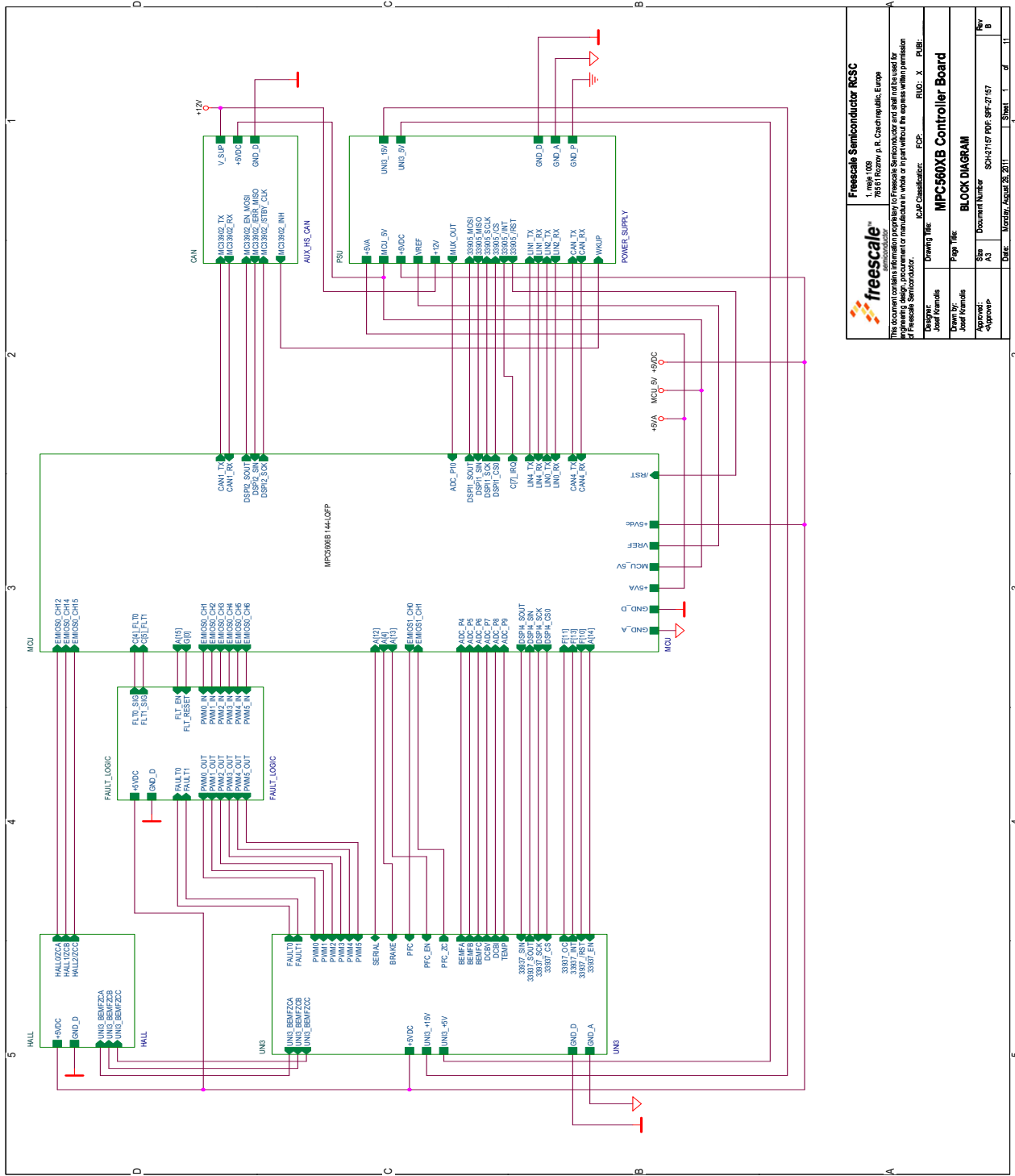
This document contains information proprietary to Freescale Semiconductor and shall not be used for engineering design, procurement or manufacture in whole or in part without the express written permission of Freescale Semiconductor.

ICAP Classification: FCP: F10; X F10B1

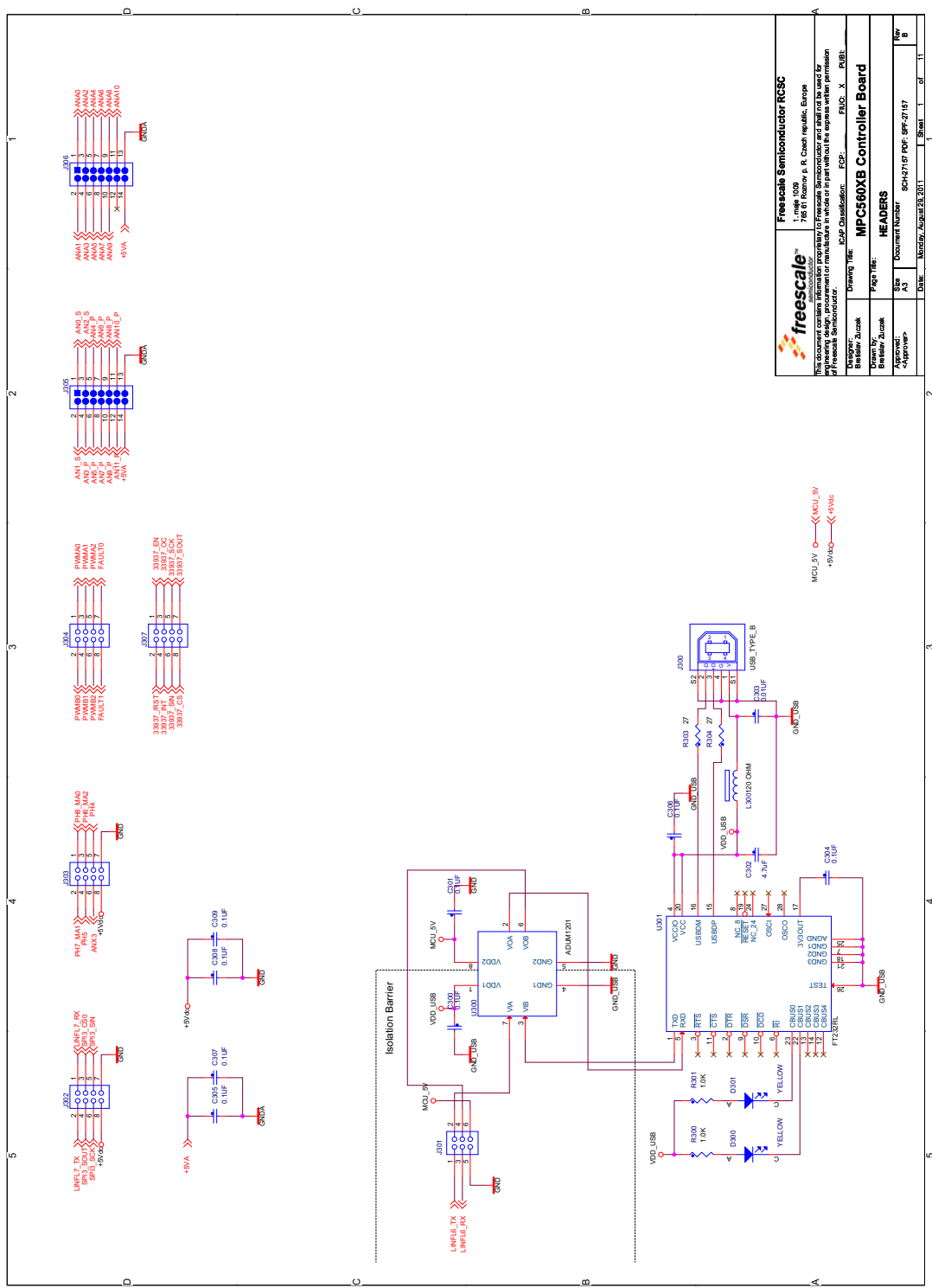
Designer: Beáta Zuzak
 Drawn by: Beáta Zuzak
 Approved: <Approver>

Drawing Title: **MPC560xB Controller Board**
 Page Title: **SCHEMATIC REVISION**

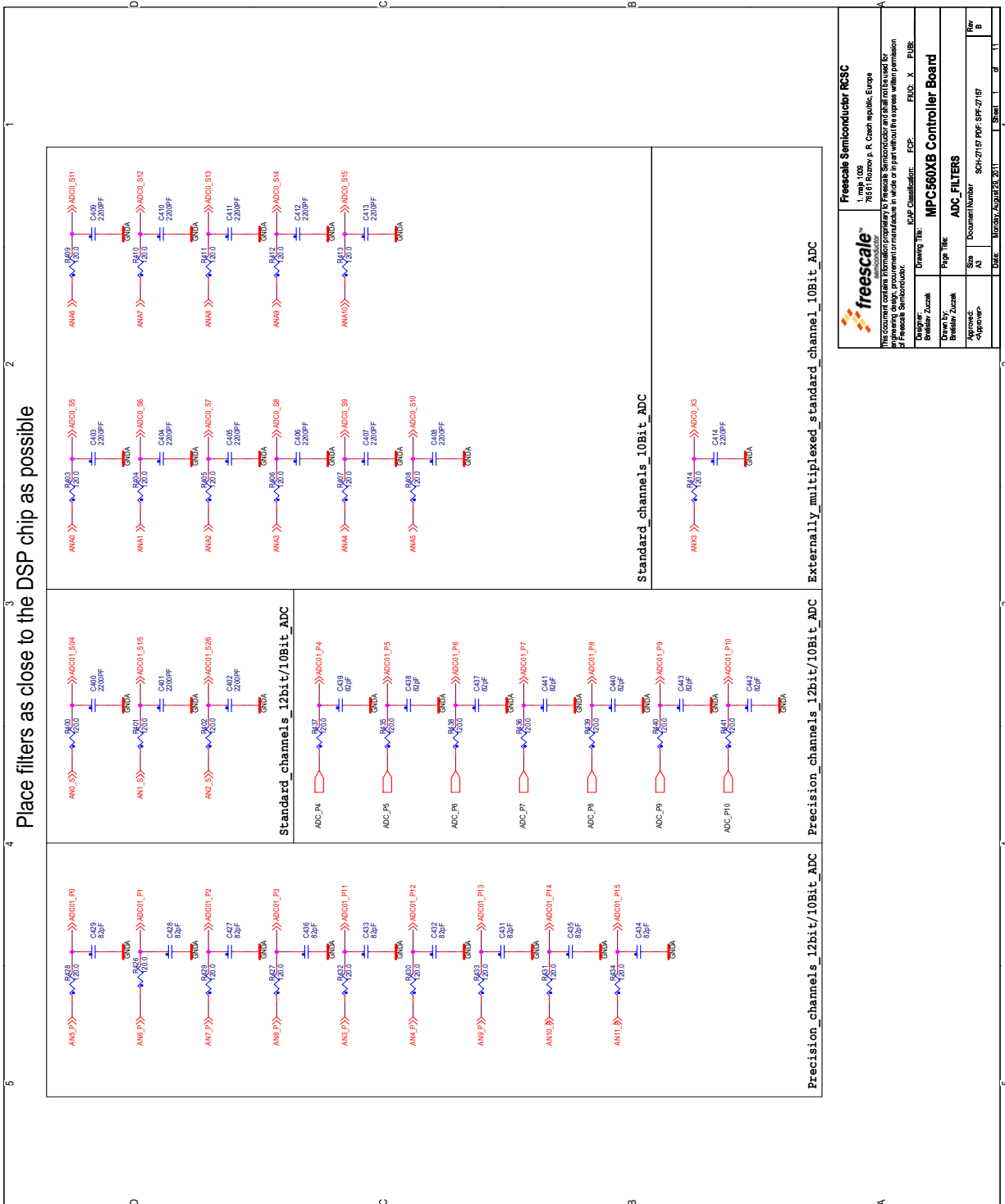
Rev: B
 Document Number: SCH2712.PDF: SPC-27157
 Date: Monday, August 28, 2011 Sheet 1 of 11



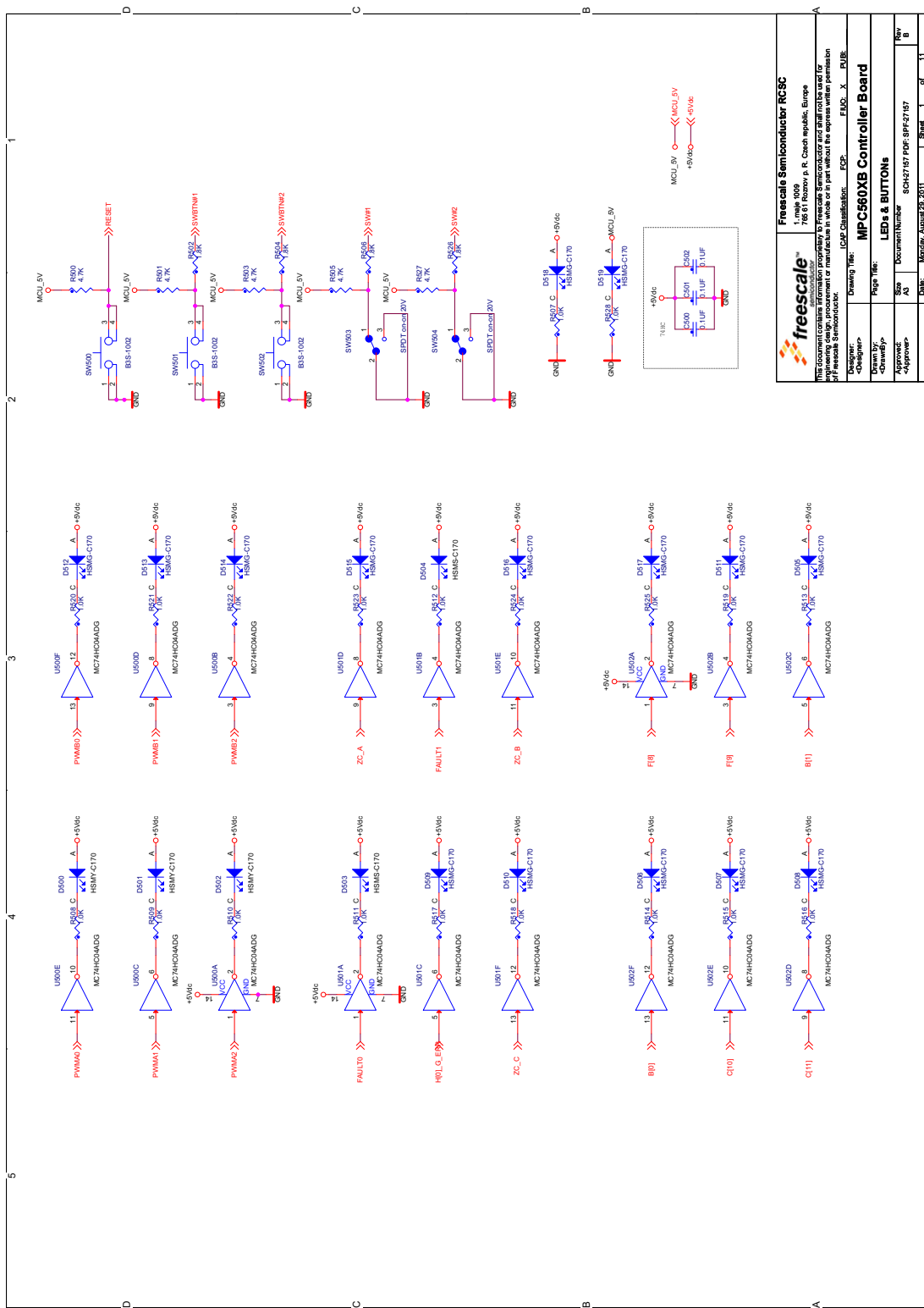
Freescale Semiconductor RCSC 1, rue 108 76151 Roissy, France	
<small>This document contains Freescale Semiconductor confidential information. It is the property of Freescale Semiconductor and shall not be used for any other purpose without the express written permission of Freescale Semiconductor.</small>	
Drawing: Joeel Kramidis	ECAP Classification: ECP
Drawing Title: Joeel Kramidis	R.O.D.: X_RIBI
Drawn by: Joeel Kramidis	MPC560xB Controller Board
Approved: <signature>	BLOCK DIAGRAM
Date: 10/27/09, August 28, 2011	Document Number: SCH2121P PDF: SPC-27157
Size: A3	Rev: B



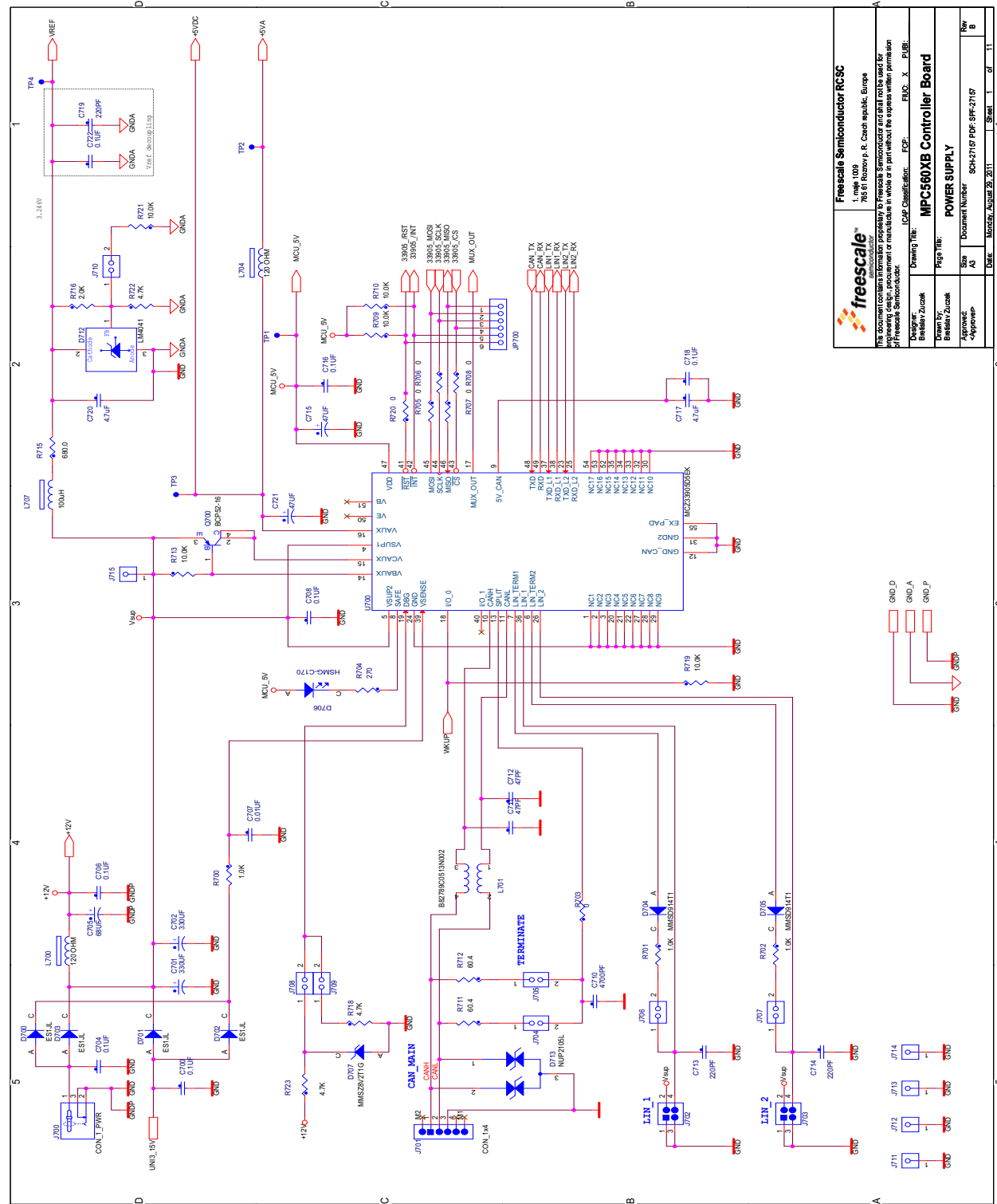
Freescale Semiconductor RCSC 1, rue de l'Industrie 786 61 Revey e. R. Clichy la Garenne, France	
This document contains information proprietary to Freescale Semiconductor and shall not be used for any other purpose without the express written permission of Freescale Semiconductor.	
EPC Classification: ...FCP...	FPC: X...RBL...
Design: MPC560xB Controller Board	Page 18: HEADERS
Drawn By: ...	Sp: ...
Checked By: ...	Document Number: SCH42167 PDF: SPR-27167
Approved By: ...	Date: ...



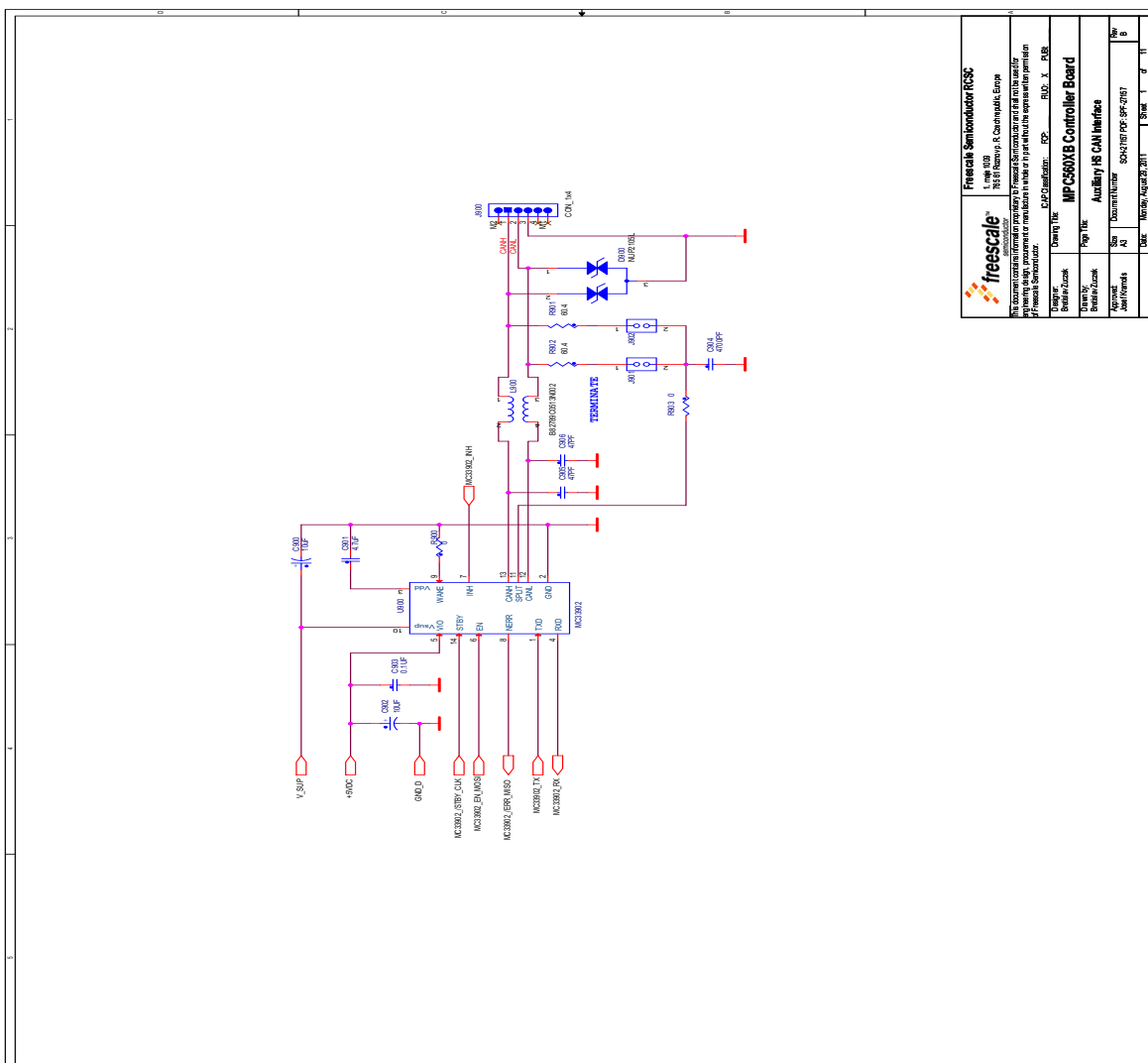
<p>Freescale Semiconductor KSCC L. Meš 008 1921 Hvezda p. R. Czech republic, Europe</p>	
<p>Uživatel tohoto dokumentu se souhlasem Freescale Semiconductor souhlasí s tím, že Freescale Semiconductor si vyhrazuje právo na změny bez předvaru. Freescale Semiconductor si vyhrazuje právo na změny bez předvaru. Freescale Semiconductor si vyhrazuje právo na změny bez předvaru. Freescale Semiconductor si vyhrazuje právo na změny bez předvaru.</p>	
<p>Design: Freescale, Zuczek</p>	<p>DocId: 30424282_2011</p>
<p>Drawn By: Freescale, Zuczek</p>	<p>DocId: 30424282_2011</p>
<p>Approved: Freescale, Zuczek</p>	<p>DocId: 30424282_2011</p>
<p>DocId: 30424282_2011</p>	<p>DocId: 30424282_2011</p>



Freescale Semiconductor Freescale Semiconductor 1960 East 10th Avenue, Channahon, IL 61018-1199, USA Freescale Semiconductor is a registered trademark of Freescale Semiconductor, Inc. All rights reserved. Freescale, the Freescale logo, and MPC560xB are trademarks of Freescale Semiconductor, Inc. or its subsidiaries in the United States and other countries. Freescale Semiconductor is not responsible for engineering design, procurement or manufacturing in whole or in part without the express written permission of Freescale Semiconductor.	
Drawing Title: MPC560xB Controller Board LCCP Classification: ECP	F.A.O. X D.U.B.
Design By: LEDs & BUTTONS Drawn By:	Document Number:
Approved:	SCHED 157 P01: SFP:27157
Date: Monday, August 24, 2010	Sheet 1 of 11



		Freescale Semiconductor RCSC 1, rue 1009 786 61 Roissy, P. R. Cedex, France	
This document contains information proprietary to Freescale Semiconductor and shall not be used for improving design, procurement or manufacture in whole or in part without the express written permission of Freescale Semiconductor.			
Design By: Brian E. Cook	Drawing Title: MPC560XB Controller Board	ICAP Classification: FCP: FUC: X: DUB:	Rev: 8
Approved By: Approver	Page Title: POWER SUPPLY	Document Number: SCH-2715F-PDF-SPE-2715F	Sheet: 1 of 11
Date: Monday, August 28, 2011			



		Freescale Semiconductor RCSC 1. 1998-2008 2. 2009-2010 3. 2011-2012 4. 2013-2014 5. 2015-2016 6. 2017-2018 7. 2019-2020 8. 2021-2022 9. 2023-2024 10. 2025-2026 11. 2027-2028 12. 2029-2030 13. 2031-2032 14. 2033-2034 15. 2035-2036 16. 2037-2038 17. 2039-2040 18. 2041-2042 19. 2043-2044 20. 2045-2046 21. 2047-2048 22. 2049-2050 23. 2051-2052 24. 2053-2054 25. 2055-2056 26. 2057-2058 27. 2059-2060 28. 2061-2062 29. 2063-2064 30. 2065-2066 31. 2067-2068 32. 2069-2070 33. 2071-2072 34. 2073-2074 35. 2075-2076 36. 2077-2078 37. 2079-2080 38. 2081-2082 39. 2083-2084 40. 2085-2086 41. 2087-2088 42. 2089-2090 43. 2091-2092 44. 2093-2094 45. 2095-2096 46. 2097-2098 47. 2099-2100 48. 2101-2102 49. 2103-2104 50. 2105-2106 51. 2107-2108 52. 2109-2110 53. 2111-2112 54. 2113-2114 55. 2115-2116 56. 2117-2118 57. 2119-2120 58. 2121-2122 59. 2123-2124 60. 2125-2126 61. 2127-2128 62. 2129-2130 63. 2131-2132 64. 2133-2134 65. 2135-2136 66. 2137-2138 67. 2139-2140 68. 2141-2142 69. 2143-2144 70. 2145-2146 71. 2147-2148 72. 2149-2150 73. 2151-2152 74. 2153-2154 75. 2155-2156 76. 2157-2158 77. 2159-2160 78. 2161-2162 79. 2163-2164 80. 2165-2166 81. 2167-2168 82. 2169-2170 83. 2171-2172 84. 2173-2174 85. 2175-2176 86. 2177-2178 87. 2179-2180 88. 2181-2182 89. 2183-2184 90. 2185-2186 91. 2187-2188 92. 2189-2190 93. 2191-2192 94. 2193-2194 95. 2195-2196 96. 2197-2198 97. 2199-2200 98. 2201-2202 99. 2203-2204 100. 2205-2206 101. 2207-2208 102. 2209-2210 103. 2211-2212 104. 2213-2214 105. 2215-2216 106. 2217-2218 107. 2219-2220 108. 2221-2222 109. 2223-2224 110. 2225-2226 111. 2227-2228 112. 2229-2230 113. 2231-2232 114. 2233-2234 115. 2235-2236 116. 2237-2238 117. 2239-2240 118. 2241-2242 119. 2243-2244 120. 2245-2246 121. 2247-2248 122. 2249-2250 123. 2251-2252 124. 2253-2254 125. 2255-2256 126. 2257-2258 127. 2259-2260 128. 2261-2262 129. 2263-2264 130. 2265-2266 131. 2267-2268 132. 2269-2270 133. 2271-2272 134. 2273-2274 135. 2275-2276 136. 2277-2278 137. 2279-2280 138. 2281-2282 139. 2283-2284 140. 2285-2286 141. 2287-2288 142. 2289-2290 143. 2291-2292 144. 2293-2294 145. 2295-2296 146. 2297-2298 147. 2299-2300 148. 2301-2302 149. 2303-2304 150. 2305-2306 151. 2307-2308 152. 2309-2310 153. 2311-2312 154. 2313-2314 155. 2315-2316 156. 2317-2318 157. 2319-2320 158. 2321-2322 159. 2323-2324 160. 2325-2326 161. 2327-2328 162. 2329-2330 163. 2331-2332 164. 2333-2334 165. 2335-2336 166. 2337-2338 167. 2339-2340 168. 2341-2342 169. 2343-2344 170. 2345-2346 171. 2347-2348 172. 2349-2350 173. 2351-2352 174. 2353-2354 175. 2355-2356 176. 2357-2358 177. 2359-2360 178. 2361-2362 179. 2363-2364 180. 2365-2366 181. 2367-2368 182. 2369-2370 183. 2371-2372 184. 2373-2374 185. 2375-2376 186. 2377-2378 187. 2379-2380 188. 2381-2382 189. 2383-2384 190. 2385-2386 191. 2387-2388 192. 2389-2390 193. 2391-2392 194. 2393-2394 195. 2395-2396 196. 2397-2398 197. 2399-2400 198. 2401-2402 199. 2403-2404 200. 2405-2406 201. 2407-2408 202. 2409-2410 203. 2411-2412 204. 2413-2414 205. 2415-2416 206. 2417-2418 207. 2419-2420 208. 2421-2422 209. 2423-2424 210. 2425-2426 211. 2427-2428 212. 2429-2430 213. 2431-2432 214. 2433-2434 215. 2435-2436 216. 2437-2438 217. 2439-2440 218. 2441-2442 219. 2443-2444 220. 2445-2446 221. 2447-2448 222. 2449-2450 223. 2451-2452 224. 2453-2454 225. 2455-2456 226. 2457-2458 227. 2459-2460 228. 2461-2462 229. 2463-2464 230. 2465-2466 231. 2467-2468 232. 2469-2470 233. 2471-2472 234. 2473-2474 235. 2475-2476 236. 2477-2478 237. 2479-2480 238. 2481-2482 239. 2483-2484 240. 2485-2486 241. 2487-2488 242. 2489-2490 243. 2491-2492 244. 2493-2494 245. 2495-2496 246. 2497-2498 247. 2499-2500 248. 2501-2502 249. 2503-2504 250. 2505-2506 251. 2507-2508 252. 2509-2510 253. 2511-2512 254. 2513-2514 255. 2515-2516 256. 2517-2518 257. 2519-2520 258. 2521-2522 259. 2523-2524 260. 2525-2526 261. 2527-2528 262. 2529-2530 263. 2531-2532 264. 2533-2534 265. 2535-2536 266. 2537-2538 267. 2539-2540 268. 2541-2542 269. 2543-2544 270. 2545-2546 271. 2547-2548 272. 2549-2550 273. 2551-2552 274. 2553-2554 275. 2555-2556 276. 2557-2558 277. 2559-2560 278. 2561-2562 279. 2563-2564 280. 2565-2566 281. 2567-2568 282. 2569-2570 283. 2571-2572 284. 2573-2574 285. 2575-2576 286. 2577-2578 287. 2579-2580 288. 2581-2582 289. 2583-2584 290. 2585-2586 291. 2587-2588 292. 2589-2590 293. 2591-2592 294. 2593-2594 295. 2595-2596 296. 2597-2598 297. 2599-2600 298. 2601-2602 299. 2603-2604 300. 2605-2606 301. 2607-2608 302. 2609-2610 303. 2611-2612 304. 2613-2614 305. 2615-2616 306. 2617-2618 307. 2619-2620 308. 2621-2622 309. 2623-2624 310. 2625-2626 311. 2627-2628 312. 2629-2630 313. 2631-2632 314. 2633-2634 315. 2635-2636 316. 2637-2638 317. 2639-2640 318. 2641-2642 319. 2643-2644 320. 2645-2646 321. 2647-2648 322. 2649-2650 323. 2651-2652 324. 2653-2654 325. 2655-2656 326. 2657-2658 327. 2659-2660 328. 2661-2662 329. 2663-2664 330. 2665-2666 331. 2667-2668 332. 2669-2670 333. 2671-2672 334. 2673-2674 335. 2675-2676 336. 2677-2678 337. 2679-2680 338. 2681-2682 339. 2683-2684 340. 2685-2686 341. 2687-2688 342. 2689-2690 343. 2691-2692 344. 2693-2694 345. 2695-2696 346. 2697-2698 347. 2699-2700 348. 2701-2702 349. 2703-2704 350. 2705-2706 351. 2707-2708 352. 2709-2710 353. 2711-2712 354. 2713-2714 355. 2715-2716 356. 2717-2718 357. 2719-2720 358. 2721-2722 359. 2723-2724 360. 2725-2726 361. 2727-2728 362. 2729-2730 363. 2731-2732 364. 2733-2734 365. 2735-2736 366. 2737-2738 367. 2739-2740 368. 2741-2742 369. 2743-2744 370. 2745-2746 371. 2747-2748 372. 2749-2750 373. 2751-2752 374. 2753-2754 375. 2755-2756 376. 2757-2758 377. 2759-2760 378. 2761-2762 379. 2763-2764 380. 2765-2766 381. 2767-2768 382. 2769-2770 383. 2771-2772 384. 2773-2774 385. 2775-2776 386. 2777-2778 387. 2779-2780 388. 2781-2782 389. 2783-2784 390. 2785-2786 391. 2787-2788 392. 2789-2790 393. 2791-2792 394. 2793-2794 395. 2795-2796 396. 2797-2798 397. 2799-2800 398. 2801-2802 399. 2803-2804 400. 2805-2806 401. 2807-2808 402. 2809-2810 403. 2811-2812 404. 2813-2814 405. 2815-2816 406. 2817-2818 407. 2819-2820 408. 2821-2822 409. 2823-2824 410. 2825-2826 411. 2827-2828 412. 2829-2830 413. 2831-2832 414. 2833-2834 415. 2835-2836 416. 2837-2838 417. 2839-2840 418. 2841-2842 419. 2843-2844 420. 2845-2846 421. 2847-2848 422. 2849-2850 423. 2851-2852 424. 2853-2854 425. 2855-2856 426. 2857-2858 427. 2859-2860 428. 2861-2862 429. 2863-2864 430. 2865-2866 431. 2867-2868 432. 2869-2870 433. 2871-2872 434. 2873-2874 435. 2875-2876 436. 2877-2878 437. 2879-2880 438. 2881-2882 439. 2883-2884 440. 2885-2886 441. 2887-2888 442. 2889-2890 443. 2891-2892 444. 2893-2894 445. 2895-2896 446. 2897-2898 447. 2899-2900 448. 2901-2902 449. 2903-2904 450. 2905-2906 451. 2907-2908 452. 2909-2910 453. 2911-2912 454. 2913-2914 455. 2915-2916 456. 2917-2918 457. 2919-2920 458. 2921-2922 459. 2923-2924 460. 2925-2926 461. 2927-2928 462. 2929-2930 463. 2931-2932 464. 2933-2934 465. 2935-2936 466. 2937-2938 467. 2939-2940 468. 2941-2942 469. 2943-2944 470. 2945-2946 471. 2947-2948 472. 2949-2950 473. 2951-2952 474. 2953-2954 475. 2955-2956 476. 2957-2958 477. 2959-2960 478. 2961-2962 479. 2963-2964 480. 2965-2966 481. 2967-2968 482. 2969-2970 483. 2971-2972 484. 2973-2974 485. 2975-2976 486. 2977-2978 487. 2979-2980 488. 2981-2982 489. 2983-2984 490. 2985-2986 491. 2987-2988 492. 2989-2990 493. 2991-2992 494. 2993-2994 495. 2995-2996 496. 2997-2998 497. 2999-3000 498. 3001-3002 499. 3003-3004 500. 3005-3006 501. 3007-3008 502. 3009-3010 503. 3011-3012 504. 3013-3014 505. 3015-3016 506. 3017-3018 507. 3019-3020 508. 3021-3022 509. 3023-3024 510. 3025-3026 511. 3027-3028 512. 3029-3030 513. 3031-3032 514. 3033-3034 515. 3035-3036 516. 3037-3038 517. 3039-3040 518. 3041-3042 519. 3043-3044 520. 3045-3046 521. 3047-3048 522. 3049-3050 523. 3051-3052 524. 3053-3054 525. 3055-3056 526. 3057-3058 527. 3059-3060 528. 3061-3062 529. 3063-3064 530. 3065-3066 531. 3067-3068 532. 3069-3070 533. 3071-3072 534. 3073-3074 535. 3075-3076 536. 3077-3078 537. 3079-3080 538. 3081-3082 539. 3083-3084 540. 3085-3086 541. 3087-3088 542. 3089-3090 543. 3091-3092 544. 3093-3094 545. 3095-3096 546. 3097-3098 547. 3099-3100 548. 3101-3102 549. 3103-3104 550. 3105-3106 551. 3107-3108 552. 3109-3110 553. 3111-3112 554. 3113-3114 555. 3115-3116 556. 3117-3118 557. 3119-3120 558. 3121-3122 559. 3123-3124 560. 3125-3126 561. 3127-3128 562. 3129-3130 563. 3131-3132 564. 3133-3134 565. 3135-3136 566. 3137-3138 567. 3139-3140 568. 3141-3142 569. 3143-3144 570. 3145-3146 571. 3147-3148 572. 3149-3150 573. 3151-3152 574. 3153-3154 575. 3155-3156 576. 3157-3158 577. 3159-3160 578. 3161-3162 579. 3163-3164 580. 3165-3166 581. 3167-3168 582. 3169-3170 583. 3171-3172 584. 3173-3174 585. 3175-3176 586. 3177-3178 587. 3179-3180 588. 3181-3182 589. 3183-3184 590. 3185-3186 591. 3187-3188 592. 3189-3190 593. 3191-3192 594. 3193-3194 595. 3195-3196 596. 3197-3198 597. 3199-3200 598. 3201-3202 599. 3203-3204 600. 3205-3206 601. 3207-3208 602. 3209-3210 603. 3211-3212 604. 3213-3214 605. 3215-3216 606. 3217-3218 607. 3219-3220 608. 3221-3222 609. 3223-3224 610. 3225-3226 611. 3227-3228 612. 3229-3230 613. 3231-3232 614. 3233-3234 615. 3235-3236 616. 3237-3238 617. 3239-3240 618. 3241-3242 619. 3243-3244 620. 3245-3246 621. 3247-3248 622. 3249-3250 623. 3251-3252 624. 3253-3254 625. 3255-3256 626. 3257-3258 627. 3259-3260 628. 3261-3262 629. 3263-3264	
--	--	---	--

How to Reach Us:

Home Page:

freescale.com

Web Support:

freescale.com/support

Information in this document is provided solely to enable system and software implementers to use Freescale products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits based on the information in this document.

Freescale reserves the right to make changes without further notice to any products herein. Freescale makes no warranty, representation, or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale data sheets and/or specifications can and do vary in different applications, and actual performance may vary over time. All operating parameters, including "typicals," must be validated for each customer application by customer's technical experts. Freescale does not convey any license under its patent rights nor the rights of others. Freescale sells products pursuant to standard terms and conditions of sale, which can be found at the following address: <http://www.reg.net/v2/webservices/Freescale/Docs/TermsandConditions.htm>

Freescale, the Freescale logo, Altivec, C-5, CodeTest, CodeWarrior, ColdFire, C-Ware, Energy Efficient Solutions logo, Kinetis, mobileGT, PowerQUICC, Processor Expert, QorIQ, Qorivva, StarCore, Symphony, and VortiQa are trademarks of Freescale Semiconductor, Inc., Reg. U.S. Pat. & Tm. Off. Airfast, BeeKit, BeeStack, ColdFire+, CoreNet, Flexis, MagniV, MXC, Platform in a Package, QorIQ Qonverge, QUICC Engine, Ready Play, SafeAssure, SMARTMOS, TurboLink, Vybrid, and Xtrinsic are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.

© 2012 Freescale Semiconductor, Inc.

Document Number: MPC560XBMCBUG

Rev. 0

08/2012

