ATA6560/1/2/3/4/6 Evaluation Kit User's Guide

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Trademarks

ISBN: 978-1-5224-2022-4

Object of Declaration: ATA6560/1/2/3/4/6 Evaluation Kit User's Guide

EU Declaration of Conformity

This declaration of conformity is issued by the manufacturer.
The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).
This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.
This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.
For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip's standard terms and conditions of sale, which are printed on our sales documentation and available at www.microchip.com.
Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA.

Rodger Richey
Director of Development Tools

4/4/17

Date

NOTES:

Table of Contents

Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the ATA6560/1/2/3/4/6 Evaluation Kit. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the ATA6560/1/2/3/4/6 Evaluation Kit as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the ATA6560/1/2/3/4/6.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with this evaluation kit and a description of the operating modes.
- **Chapter 3. "Hardware Description"** - Describes the external elements required for some of the pins.
- **Chapter 4. "Applications"** - Describes the typical application circuits.
- **Chapter 5. "Test Setups and Measurements"** - Describes the timing measurements and hints for ATA6560/1/2/3/4/6.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the ATA6560/1/2/3/4/6.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the ATA6560/1/2/3/4/6 Evaluation Kit.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use the ATA6560/1/2/3/4/6 Evaluation Kit. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resource:

- **ATA6560/1 Data Sheet -** ***"High-speed CAN Transceiver with Standby Mode CAN FD Ready"***
- **ATA6562/3 Data Sheet -** ***"High-speed CAN Transceiver with Standby Mode CAN FD Ready" (DS20005790A)***
- **ATA6564 Data Sheet -** ***"High-speed CAN Transceiver with Silent Mode CAN FD Ready" (DS20005784A)***
- **ATA6566 Data Sheet -** ***"High-speed CAN Transceiver with Standby Mode for the Japanese Market" - CAN FD Ready (DS20005783A)***

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (August 2017)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the ATA6560/1/2/3/4/6 Evaluation Kit and covers the following topics:

- ATA6560/1/2/3/4/6 Short Overview
- What is the ATA6560/1/2/3/4/6 Evaluation Kit?
- Contents of the ATA6560/1/2/3/4/6 Evaluation Kit

1.2 ATA6560/1/2/3/4/6 SHORT OVERVIEW

The ATA6560/1/2/3/4/6 is a high-speed CAN transceiver family that provides an interface between a controller area network (CAN) protocol controller and the physical two-wire CAN bus. The transceiver is designed for high-speed (up to 5 Mbit/s) automotive CAN applications delivering differential transmit and receive capability to (a microcontroller with) a CAN protocol controller. It offers superior electromagnetic compatibility (EMC) and electrostatic discharge (ESD) performance, as well as features such as:

- Ideal passive behavior to the CAN bus when the supply voltage is off
- Direct interfacing to microcontrollers with supply voltages from 3V to 5V (ATA6561, ATA6563, ATA6564, ATA6566)

Three operating modes together with dedicated fail-safe features make the ATA6560/1/2/3/4/6 an excellent choice for all types of high-speed CAN networks, especially in nodes requiring low-power mode with wake-up capability via the CAN bus.

The ATA6560/1/2/3/4/6 CAN transceivers are very similar, they mainly differ in the function of pin 5 and pin 8 as depicted in the following table:

TABLE 1-1: ATA6560/1/2/3/4/6 PIN FUNCTIONS

Pin	ATA6560	ATA6561	ATA6562	ATA6563	ATA6564	ATA6566
1	TXD	TXD	TXD	TXD	TXD	TXD
2	GND	GND	GND	GND	GND	GND
3	VCC	VCC	VCC	VCC	VCC	VCC
4	RXD	RXD	RXD	RXD	RXD	RXD
5	NSIL	VIO	NSIL	VIO	VIO	VIO
6	CANL	CANL	CANL	CANL	CANL	CANL
7	CANH	CANH	CANH	CANH	CANH	CANH
8	STBY	STBY	STBY	STBY	S	STBY
Bus - Wake-up						
Single dom puls	X	X	—	—	n/a	—
Wake-up pattern	—	—	X	X	n/a	X

The ATA6560/1/2/3/4/6 CAN transceivers are available in SOIC8 and VDFN8 packages for space-saving application, as shown in Figure 1-1 and Figure 1-2. There are footprints for both package types on the development board.

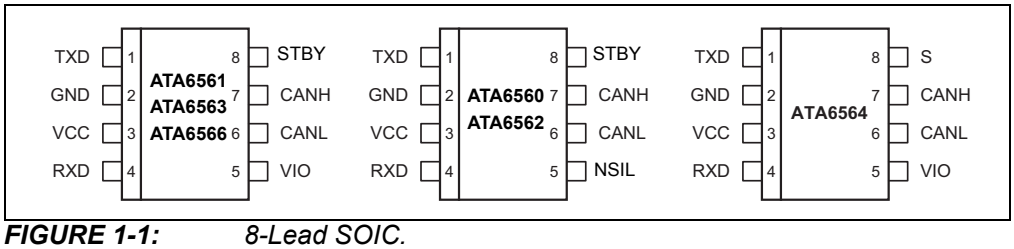


FIGURE 1-1: *8-Lead SOIC.*

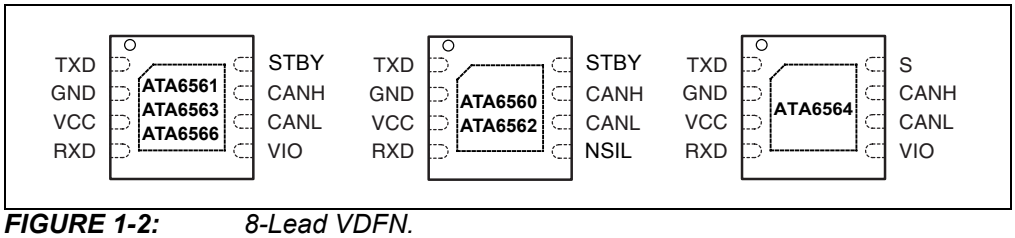


FIGURE 1-2: *8-Lead VDFN.*

1.3 WHAT IS THE ATA6560/1/2/3/4/6 EVALUATION KIT?

The ATA6560/1/2/3/4/6 Evaluation Kit enables users to rapidly carry out prototyping and testing of new CAN designs with the ATA6560/1/2/3/4/6 high-speed CAN transceivers.

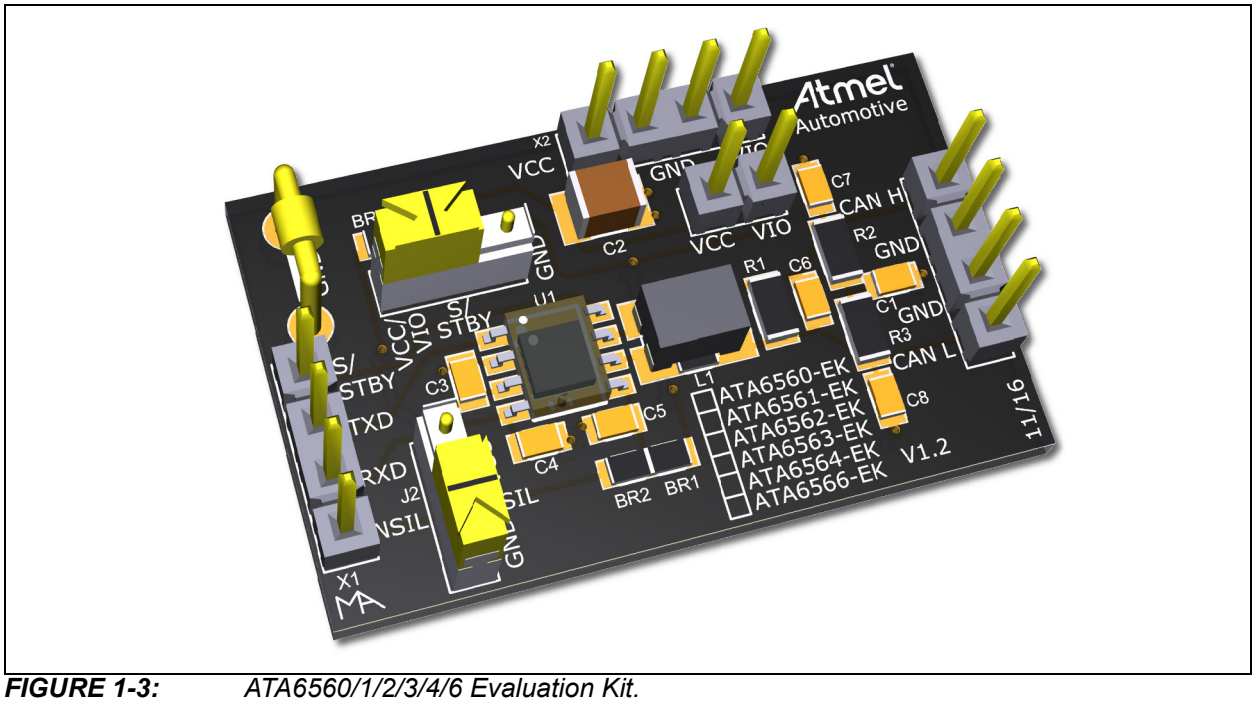


FIGURE 1-3: *ATA6560/1/2/3/4/6 Evaluation Kit.*

1.4 CONTENTS OF THE ATA6560/1/2/3/4/6 EVALUATION KIT

This ATA6560/1/2/3/4/6 Evaluation Kit includes:

- ATA6560/1/2/3/4/6 Evaluation Board (ADM00869)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 DEVELOPMENT KIT

The ATA6560/1/2/3/4/6 Evaluation Kit supports the following features:

- All components necessary to put the ATA6560/1/2/3/4/6 into operation are included
- Placeholders for some optional components for extended functions are included (e.g., common-mode choke)
- All pins are easily accessible
- Footprint for VDFN8 and SOIC8 packages
- Ground coulter clip for easy probe connection during oscilloscope measurement

2.2 FEATURES

- Fully Compliant with ISO 11898-2,-5 and SAE J2962-2
- Low Electromagnetic Emission (EME) and High Electromagnetic Immunity (EMI)
- Communication Speed up to 5 Mbit/s
- Differential Receiver with Wide Common-Mode Range
- Silent Mode (receive only mode, available only for ATA6560, ATA6562 and ATA6564)
- Standby Mode (not for ATA6564)
- Remote Wake-Up Capability via CAN Bus (not for ATA6564)
- Functional Behavior Predictable under All Supply Conditions
- Transceiver Disengages from the Bus When Not Powered-Up
- RXD Recessive Clamping Detection
- High Electrostatic Discharge (ESD) Handling Capability on the Bus Pins
- Bus Pins Protected against Transients in Automotive Environments
- Transmit Data (TXD) Dominant Time-Out Function
- Undervoltage Detection on VCC and VIO Pins
- CANH/CANL Short-Circuit and Overtemperature Protected

2.3 QUICK START

The ATA6560/1/2/3/4/6 Evaluation Kit is shipped including all components, allowing immediate CAN node development.

Connecting an external 5V DC power supply between the terminals VCC and GND puts the IC in one of the three operating modes: Normal, Silent (with ATA6560, ATA6562 and ATA6564 only) and Standby, which can be selected via the STBY and NSIL pins (see **Section 3.8 "System Control Pins (STBY, NSIL, S)"**). See Table 2-1 for a description of the operating modes under normal supply conditions.

TABLE 2-1: OPERATING MODES

Mode	Inputs				Outputs	
	STBY	NSIL[5]	S[6]	Pin TXD	CAN Driver	Pin RXD
Normal	LOW	HIGH[2]	LOW	LOW	Dominant	LOW
	LOW	HIGH[2]	LOW	HIGH	Recessive	HIGH
Standby	HIGH	x[3]	—	x[3]	Recessive	Active[4]
Silent	LOW	LOW	HIGH	x[3]	Recessive	Active[1]

Note 1: LOW if the CAN bus is dominant, HIGH if the CAN bus is recessive.

2: Internally pulled up if not bonded out.

3: Irrelevant.

4: Reflects the bus only for wake-up.

5: Only ATA6560 and ATA6562.

6: Only ATA6564.

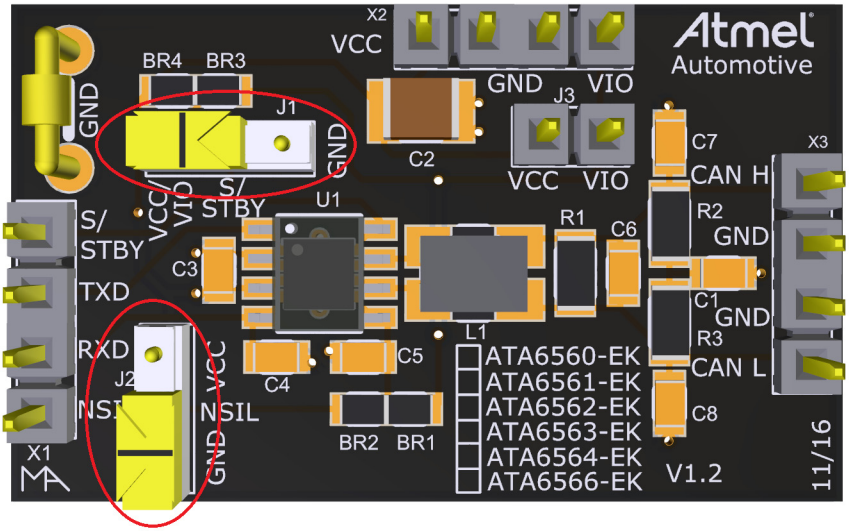


FIGURE 2-1: *Switch Jumpers for Changing the Operating Mode (J2 Available for ATA6560 and ATA6562 only).*

2.4 NORMAL MODE

A low level on the STBY pin together with a high level on pins TXD and NSIL (ATA6560 and ATA6562) or a low level on the S pin (ATA6564) selects the Normal mode. In this mode, the transceiver is able to transmit and receive data via the CANH and CANL bus lines. The output driver stage is active and drives data from the TXD input to the CAN bus. The high-speed comparator (HSC) converts the analog data on the bus lines into digital data which is output to the RXD pin. The bus biasing is set to VCC/2 and the undervoltage monitoring of VCC is active.

The slope of the output signals on the bus lines is controlled and optimized in a way that guarantees the lowest possible electromagnetic emission (EME).

To switch the device in normal operating mode, set the STBY pin to low (switch jumper J1 set to the right side) and the NSIL pin (if available) to high (switch jumper J2 set to upper position). For example, for test purposes a signal generator can also be connected to the STBY pin and/or to the NSIL pin (at the pin header X1 on the left side of the board). Therefore the switch jumper J1 and/or J2 should be set to the middle position.

The STBY and the NSIL pins each provide a pull-up resistor to VIO respectively VCC, the S pin a pull-down resistor to GND, thus ensuring defined levels if the pins are open.

Note: The device cannot enter Normal mode as long as the TXD is at GND level.

2.5 SILENT MODE (WITH ATA6560, ATA6562 AND ATA6564 ONLY)

For the ATA6560 and ATA6562, a low level on the NSIL and STBY pins switches the devices into Silent mode. The ATA6564 switches into Silent mode, when a high level is applied to the S pin. This receive-only mode can be used to test the connection of the bus medium. In Silent mode, the ATA6560, ATA6562 and ATA6564 can still receive data from the bus, but the transmitter is disabled and therefore no data can be sent to the CAN bus. The bus pins are released to recessive state. All other IC functions, including the high-speed comparator (HSC), continue to operate as they do in Normal mode. Silent mode can be used to prevent a faulty CAN controller from disrupting all network communications.

2.6 STANDBY MODE (NOT FOR THE ATA6564)

A high level on the STBY pin selects the Standby mode. In this mode, the transceiver is not able to transmit or correctly receive data via the bus lines. The transmitter and the high-speed comparator (HSC) are switched off to reduce current consumption and only the low-power wake-up comparator (WUC) monitors the bus lines for a valid wake-up signal. For the ATA6560 and ATA6561, a signal change on the bus from Recessive to Dominant, followed by a dominant state longer than t_{wake}, switches the RXD pin to low to signal a wake-up request to the microcontroller.

The ATA6562, ATA6563 and ATA6566 do not wake-up with a single long dominant phase on the bus, they only wake-up when they receive a wake-up pattern (WUP).

The wake-up pattern consists of at least two consecutive dominant bus levels for a duration of at least t_{Filter} (0.5 µs-3.8 µs), each separated by a recessive bus level with a duration of at least t_{Filter} (0.5 µs-3.8 µs). This filtering helps to avoid spurious wake-up events, which would be triggered by scenarios such as a dominant clamped bus or by a dominant phase due to noise, spikes on the bus, automotive transients or EMI.

In Standby mode, the bus lines are biased to ground to reduce current consumption to a minimum. The wake-up comparator (WUC) monitors the bus lines for a valid wake-up signal. When the RXD pin switches to low to signal a wake-up request, a transition to Normal mode is not triggered until the STBY pin is forced back to low by the microcontroller. A bus dominant time-out timer prevents the device from generating a permanent wake-up request by switching the RXD pin to high.

For the ATA6560 and ATA6562, if the NSIL input pin is set to low in Standby mode, the internal pull-up resistor causes an additional quiescent current from VCC to GND. It is recommended to set the NSIL pin to high in standby mode.

NOTES:

Chapter 3. Hardware Description

3.1 PIN DESCRIPTION

The following sections show and describe the external elements required for some of the pins. See the specific datasheet for more information about this topic.

3.2 POWER SUPPLY

In order to get the development board running, an external stabilized 5V DC power supply has to be connected to the VCC header. The maximum rating for the VCC pin is 5.5V and a higher voltage may cause permanent damage to the device.

3.3 VIO SUPPLY PIN

There are two available device versions, with a different function of pin 5:

- On the ATA6561, ATA6563, ATA6564 and ATA6566, pin 5 is VIO and should be connected to the supply voltage of the connected microcontroller. This adjusts the signal levels of the TXD, RXD, NSIL, S and STBY pins to the I/O levels of the microcontroller. A jumper is implemented on the board (J3) connecting VIO to VCC for test purposes or quick measurements. If the VIO pin has to be supplied with a different voltage, jumper J3 has to be removed and the VIO pin header connected to the second external DC power supply (typically 3.3V).
- On the ATA6560 and ATA6562 without the VIO pin, the VIO input is internally connected to VCC. This sets the signal levels of the TXD, RXD, STBY and NSIL pins to levels compatible with 5V microcontrollers.

3.4 CAN INTERFACE (CANH, CANL, TXD, RXD)

The CAN transceiver is only active when it is in Normal mode. In Silent mode the transmitter is switched off and the ATA6560, ATA6562 and ATA6564 are in receive-only mode. In Standby mode the transceiver is completely switched off and no communication is possible. Only a low power wake-up comparator (WUC) is active in order to reflect the bus for a wake-up (not with the ATA6564).

3.5 CANH AND CANL PINS

The CANH and CANL pins are the interface to the bus network. Nodes connected to the bus end must show a differential termination, which is approximately equal to the characteristic impedance of the bus line in order to suppress signal reflection. Instead of a one-resistor termination it is highly recommended to use a so-called split termination. EMC measurements have shown that the split termination is able to significantly improve the signal symmetry between CANH and CANL, thus reducing the emission. Basically each of the two termination resistors is split into two resistors of equal value, i.e., two resistors of 60Ω (or 62Ω) (R2 and R3) instead of one resistor of 120Ω. The special characteristic of this approach is that the common-mode signal, available at the center tap of the termination, is terminated to ground via a capacitor. The recommended value for this capacitor is in the range of 4.7 nF to 47 nF (C7).

As the symmetry of the two signal lines is crucial for the emission performance of the system, the matching tolerance of the two termination resistors should be as low as possible (< 1% is desirable).

In addition, loading the CANH and CANL pins each with a capacitor of about 100 pF close to the connector of the ECU (there are placeholders on the PCB for the capacitors C7 and C8) is recommended. The main reason for doing this is to increase the robustness to automotive transients and ESD. The matching tolerance of the two capacitors should be as low as possible.

OEM specifications may require dedicated circuits. Refer to the corresponding OEM specifications for specific details.

The footprint for an optional common-mode choke, to improve EMC performance, is implemented (L1).

Placeholders (R1, C6 and C4) are implemented on the board for timing measurements.

3.6 TXD INPUT PIN

The signal sent to the TXD input pin controls the state of the CANH/CANL outputs. An internal pull-up resistor to VIO is implemented. The TXD input pin must be pulled to ground in order to drive the CAN bus into dominant state.

An internal timer prevents the bus lines from being driven permanently into the dominant state. If TXD is forced to low longer than $t_{to(DOM)TXD} > 3$ ms, the transceiver internally switches the TXD state to high and the CAN bus driver is switched to the recessive state. This feature is used to prevent a single faulty node (for example with a short to ground at the TXD pin) from paralyzing communication on the entire CAN bus the faulty node is connected to.

3.7 RXD OUTPUT PIN

This pin reports the state of the CAN bus to the microcontroller. CAN high (recessive state) is reported by a high level at RXD; CAN low (dominant state) is reported by a low level at RXD. The RXD output is a push-pull stage and is short-circuit protected.

3.8 SYSTEM CONTROL PINS (STBY, NSIL, S)

These input pins are used for mode control. They are typically directly connected to an output port pin of a microcontroller. The ATA6560/1/2/3/4/6 supports three operating modes: Normal, Silent (only with the ATA6560, ATA6562 and ATA6564) and Standby (not with the ATA6564), which can be selected via the STBY, S and NSIL pins. See Table 2-1 for a description of the operating modes under normal supply conditions.

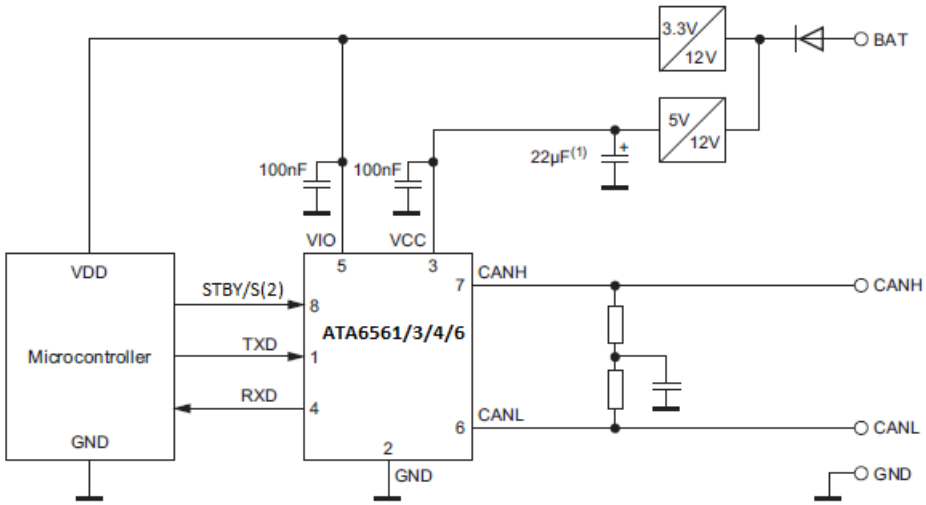
The STBY and the NSIL pins each provide a pull-up resistor to VIO, respectively VCC. The S pin of the ATA6564 provides a pull-down resistor to GND, thus ensuring defined levels if the pins are open.

The operating mode can be easily changed via the on-board switch jumpers (switch jumper J1 for STBY/S pin control and switch jumper J2 for NSIL pin control). If desired, this can be done also via an external signal generator, but therefore the switch jumper J1 and/or J2 should be set to the middle position.

Chapter 4. Applications

4.1 TYPICAL APPLICATION CIRCUITS

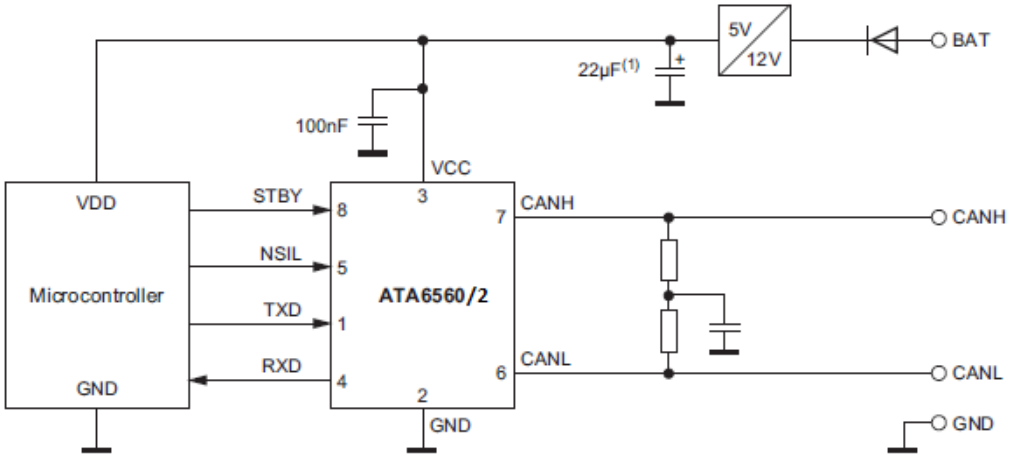
Figure 4-1 and Figure 4-2 illustrate typical circuit examples using the ATA6560/1/2/3/4/6 devices. The application examples assume either a 5V or a 3V supplied host microcontroller. In each example there is a dedicated 5V regulator supplying the ATA6560/1/2/3/4/6 transceiver on its VCC supply pin (necessary for proper CAN transmit capability). Depending on which device is soldered on the board, all corresponding components required are mounted on the board.



Note 1: The size of this capacitor depends on the used external voltage regulator.

2: S pin only for the ATA6564.

FIGURE 4-1: *Typical Application Circuit ATA6561/3/4/6 – the VIO Pin Allows Direct Interfacing to Microcontrollers with Supply Voltages Down to 2.8V.*



Note 1: The size of this capacitor depends on the used external voltage regulator.

FIGURE 4-2: *Typical Application Circuit ATA6560 and ATA6562 – the NSIL Pin Allows the Device to be Switched to Receive-Only Mode, Only One LDO is Necessary with a 5V Microcontroller.*

Chapter 5. Test Setups and Measurements

5.1 TIMING MEASUREMENTS

The required components on the basic application board can be found below. A two-channel, or optimally, a four-channel oscilloscope is sufficient to measure the timing characteristics of the ATA6560/1/2/3/4/6. The transmit data signal TXD can be generated by any signal generator that is capable of delivering a rectangular or pulse signal with 3.3V to 5V amplitude, referred to GND. The characteristics of TXD, RXD and the CANH, CANL signals can be examined.

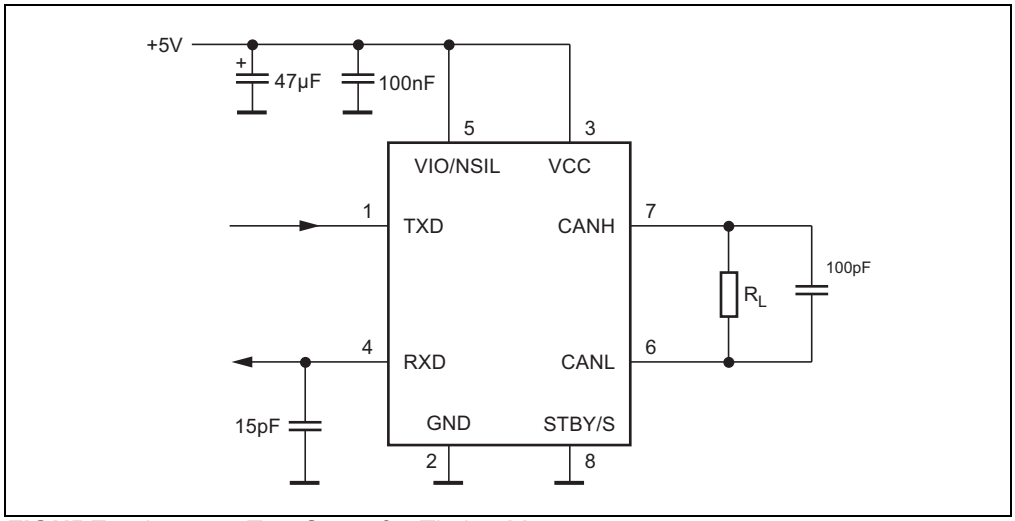


FIGURE 5-1: *Test Setup for Timing Measurements.*

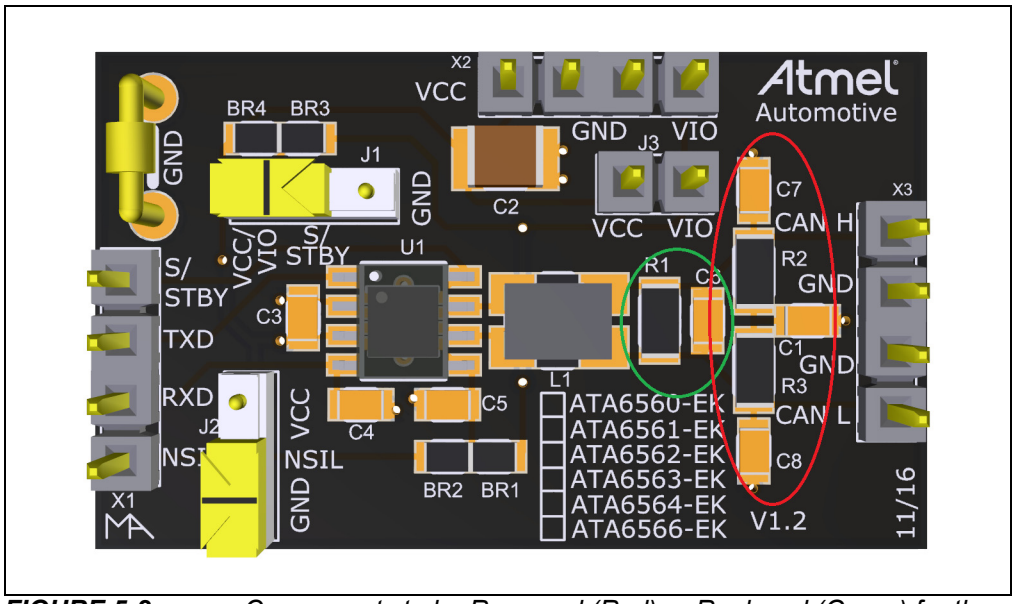


FIGURE 5-2: *Components to be Removed (Red) or Replaced (Green) for the Timing Measurement Setup.*

The footprint for an optional common-mode choke (L1) is implemented on the development board. This common-mode choke (L1) is per default replaced by two 0Ω resistors.

Instead of a one-resistor termination, it is highly recommended to use the commonly used so-called split termination, which is per default assembled. EMC measurements have shown that the split termination is able to significantly improve the signal symmetry between CANH and CANL, thus reducing emissions. Basically the termination is split into two resistors of equal value (R2 = R3 = 62Ω) and a capacitor (C1) to GND at the center tap, which represents one of the two usual bus end terminations. The special characteristic of this approach is that the common-mode signal, available at the center tap of the two resistors, is terminated to ground via the capacitor C1. The recommended value for this capacitor C1 is in the range of 4.7 nF to 47 nF (4.7 nF assembled per default).

As the symmetry of the two signal lines is crucial for the emission performance of the system, the matching tolerance of the two termination resistors R1 and R2 should be as low as possible (< 1% is desirable).

Additionally placeholders are implemented on the board for timing measurements (R1, C6 and C4). If a function generator is connected to the TXD header, it can be adjusted to output a rectangular signal up to a frequency corresponding to the maximum data rate of the final application. Pay attention that its output signal levels are in the appropriate range particularly that no negative voltage occurs. The function generator can be replaced by a dedicated data generator in order to form a better approach to the desired application. The high-impedance inputs of the oscilloscope can be connected directly - however it's advantageous to use probes, so that the signals are not noticeably affected by the capacitance of the coaxial cable.

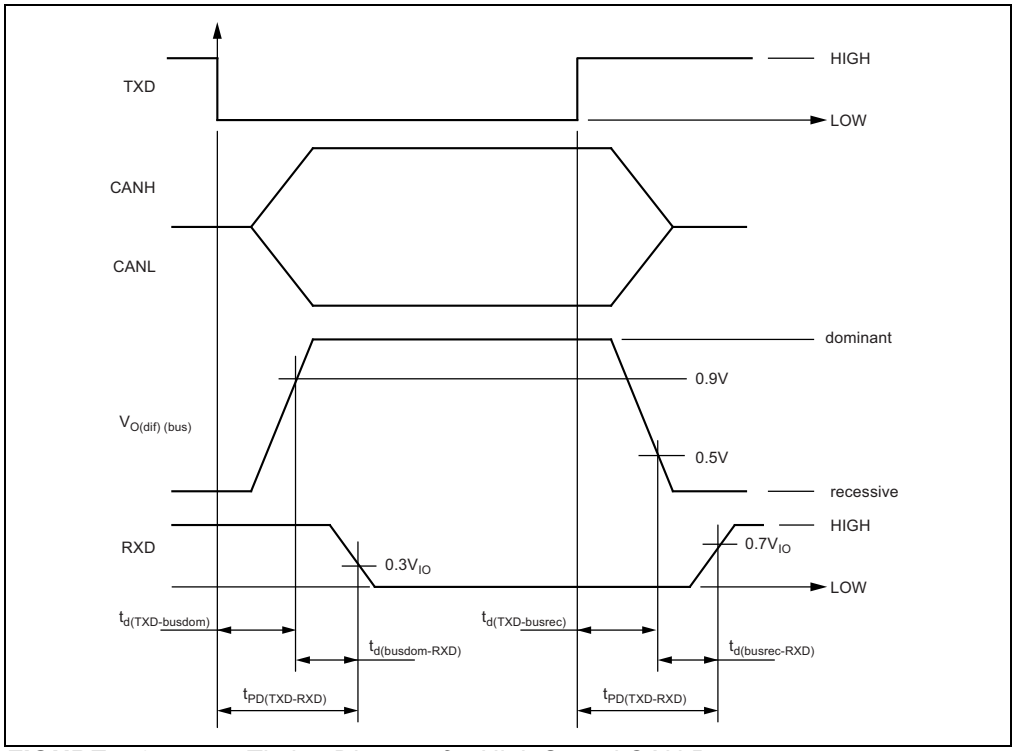


FIGURE 5-3: *Timing Diagram for High Speed CAN Bus.*

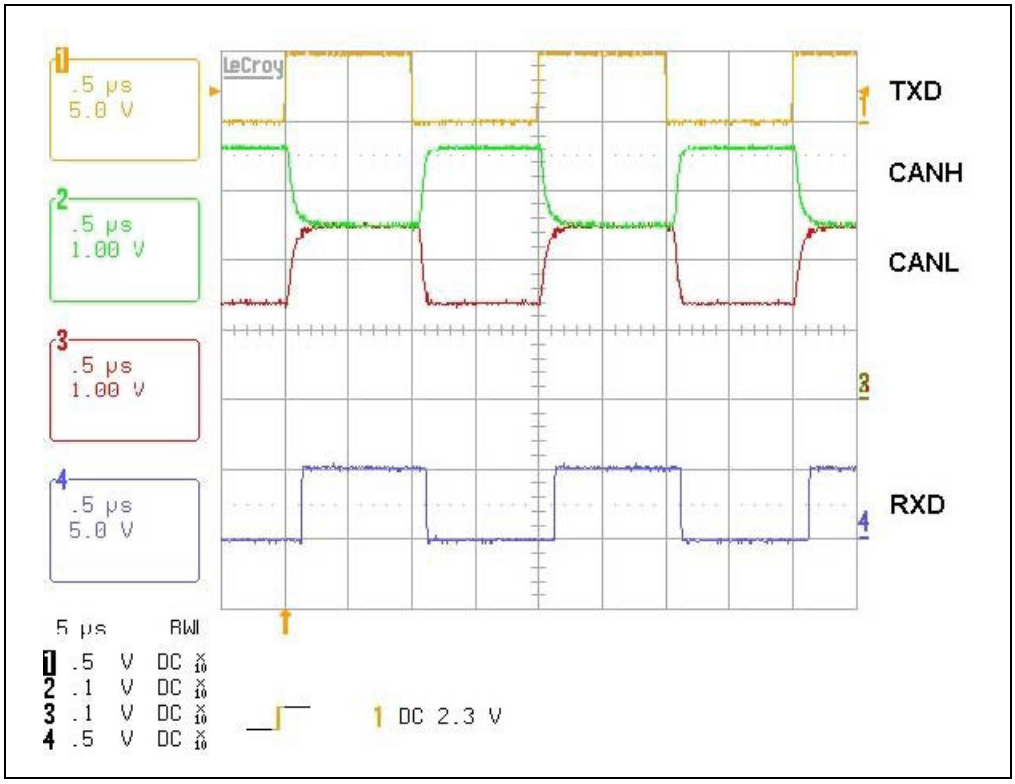


FIGURE 5-4: *Measurement of the TXD, CANH, CANL and RXD Signal at a Data Rate of 1 Mbit/s.*

Figure 5-4 shows the typical bus line signals for a 0-1 bit sequence at a data rate of 1 Mbit/s and VCC = VIO = 5V. The excellent symmetry of the CANH and CANL signals ensures superior EMC performance.

5.2 MEASUREMENT HINTS

5.2.1 Passive Behavior

In many applications, some transceivers can become unpowered (e.g., clamp-15 nodes) while other transceivers are continuously supplied (e.g., clamp-30 nodes). In such networks, the ATA6560/1/2/3/4/6 is favored for partially unpowered applications because of its excellent passive behavior to the bus when the VCC supply is switched off. In addition, the ATA6560/1/2/3/4/6 is protected against reverse currents via the TXD, RXD,NSIL, S and STBY pins. There is no backward current via those pins if the accompanying microcontroller continues to be supplied.

5.2.2 Optional Circuitry at CANH and CANL

The EMC performance of the ATA6560/1/2/3/4/6 has been optimized for the use of CAN termination without a common-mode choke. The excellent output stage symmetry allows use without chokes. If, however, system performance is still not sufficient, there is the option of using additional measures such as common-mode chokes (a footprint for a common-mode choke is implemented at the ATA6560/1/2/3/4/6 Evaluation Kit), capacitors, and ESD clamping diodes.

5.2.2.1 COMMON-MODE CHOKE

> **Note:** If any critical measurements on EMI (electromagnetic interference) performance, such as electromagnetic immunity or electromagnetic emission, are to be taken, Microchip recommends a dedicated board with a highly symmetrical layout for the bus lines and ground vias at each connection to the ground plane. For investigations on complete links such as bit error measurements, a test board with at least two transceivers is required in any case.

A common-mode choke provides high impedance for common-mode signals and low impedance for differential signals. Because of this, common-mode signals produced by RF noise and/or by non-perfect transceiver driver symmetry are effectively reduced while passing the choke. In fact, a common-mode choke helps to reduce emission and to improve immunity against common-mode disturbances. Earlier transceiver devices usually needed a common-mode choke to comply with stringent emission and immunity requirements of the automotive industry when using unshielded twisted-pair cables.The ATA6560/1/2/3/4/6 makes it possible to build in-vehicle bus systems without chokes. Whether a choke is needed or not ultimately depends on the specific system implementation such as the wiring harness and the symmetry of the two bus lines (matching tolerances of resistors and capacitors). Besides the RF noise reduction, the stray inductance (non-coupled portion of inductance) may establish a resonant circuit together with pin capacitance. This can result in unwanted oscillations between the bus pins and the choke both with differential and common-mode signals as well as result in extra emission around the resonant frequency. To avoid oscillations of this kind, it is highly recommended to use only chokes with a stray inductance lower than 500 nH. Bifilar wound chokes typically show an even lower stray inductance. The choke should be placed nearest to the transceiver bus pins.

The use of common-mode chokes in CAN systems might cause extremely high transient voltages at the bus pins of the transceiver. These transients are generated by the change in current through the inductance of the common-mode chokes if the CAN bus is shorted to DC voltages. The actual transients that might be generated are highly dependent on the common-mode type and value, but also depend on the CAN system architecture, termination, components, location and the severity of the short circuit.

For systems where common-mode chokes are required, care should be used in the choice of the common-mode choke and the system circuit to avoid the introduction of severe transients during DC short-circuit conditions on the bus.

The best methods to avoid transients generated from common-mode chokes during CAN bus line shorts to DC voltages are:

- Remove common-mode chokes from systems, where applicable
- Move transient suppression circuits between the common-mode choke and the CAN bus pins on the transceiver
- Choose a dedicated common-mode choke and a CAN termination scheme to minimize transients

5.2.2.2 CAPACITORS

Matched capacitors (in pairs) at CANH and CANL to GND are frequently used to enhance immunity against electromagnetic interferences. Along with the impedance of corresponding noise sources (RF), capacitors at CANH and CANL to GND form an RC low-pass filter. Regarding immunity, the capacitor value should be as large as possible to achieve a low corner frequency. The overall capacitive load and impedance of the output stage establish an RC low-pass filter for the data signals. The associated corner

frequency must be well above the data transmission frequency. This results in a limit for the capacitor value depending on the number of nodes and the data transmission frequency. Notice that capacitors increase the signal loop delay due to longer rise and fall times. Due to these time reductions, bit timing requirements, especially at 1 Mbit/s, call for a value lower than 100 pF (see also SAE J2284 and ISO 11898). At a bit rate of 125 kBit/s the capacitor value should not exceed 470 pF. Typically, the capacitors are placed between the common-mode choke (if applied at all) and the ESD clamping diodes

5.2.2.3 ESD PROTECTION

The ATA6560/1/2/3/4/6 is designed to withstand ESD pulses of up to 8 kV according to the human body model at the CANH and CANL bus pins and thus typically does not need any additional external protection methods. Nevertheless, if a higher protection level is required, external clamping devices can be applied to the CANH and CANL lines.

Care must be taken when selecting the right protection devices. The transient protectors must be fast enough to clamp the transient voltages. In addition, their capacitance must be considered. If the capacitance is too high, it can work together with the choke's inductance and cause ringing on the bus signals. Although this ringing does not corrupt the CAN signals, it might show up as electromagnetic emission at higher frequencies.

NOTES:

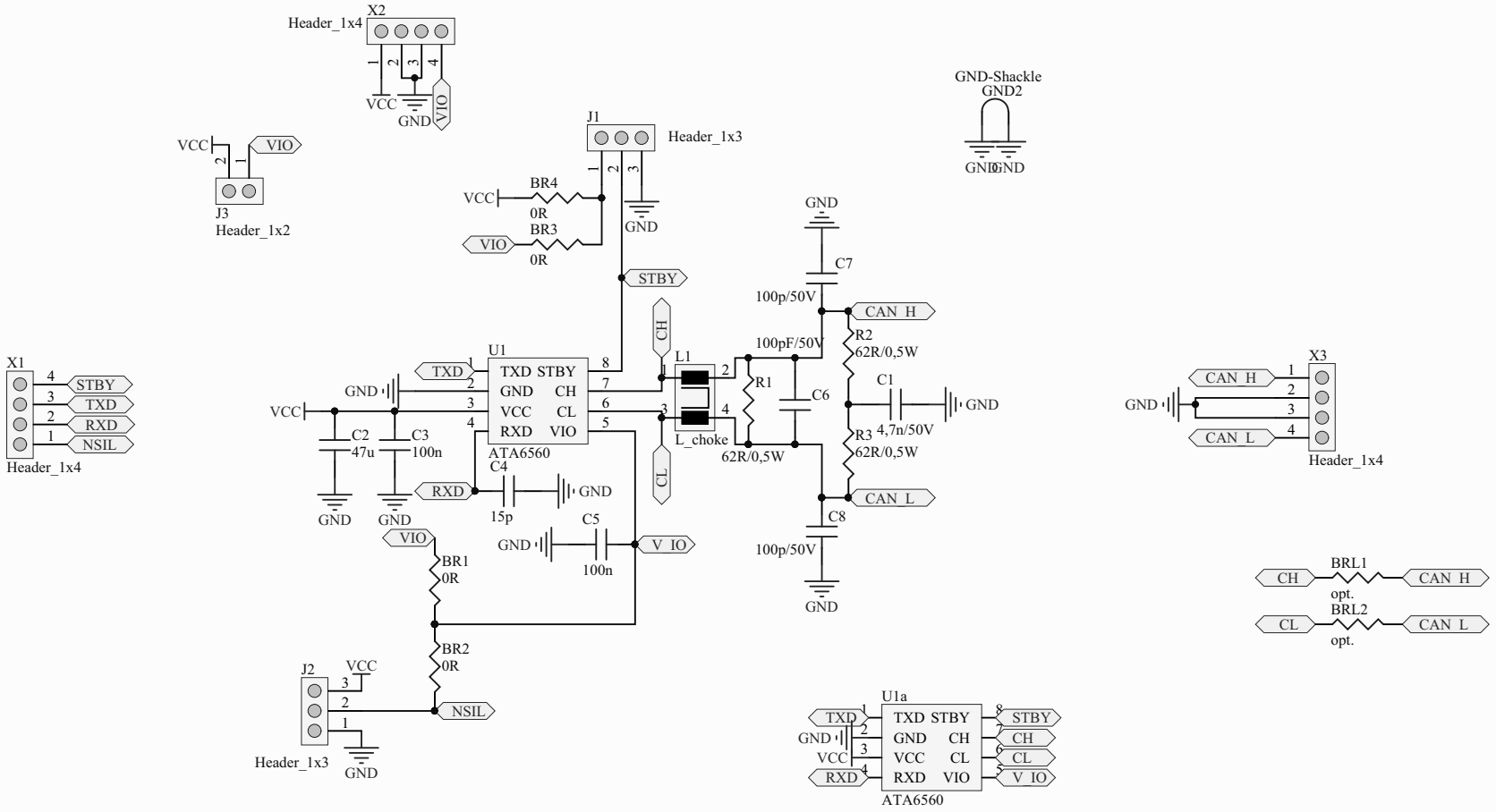
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

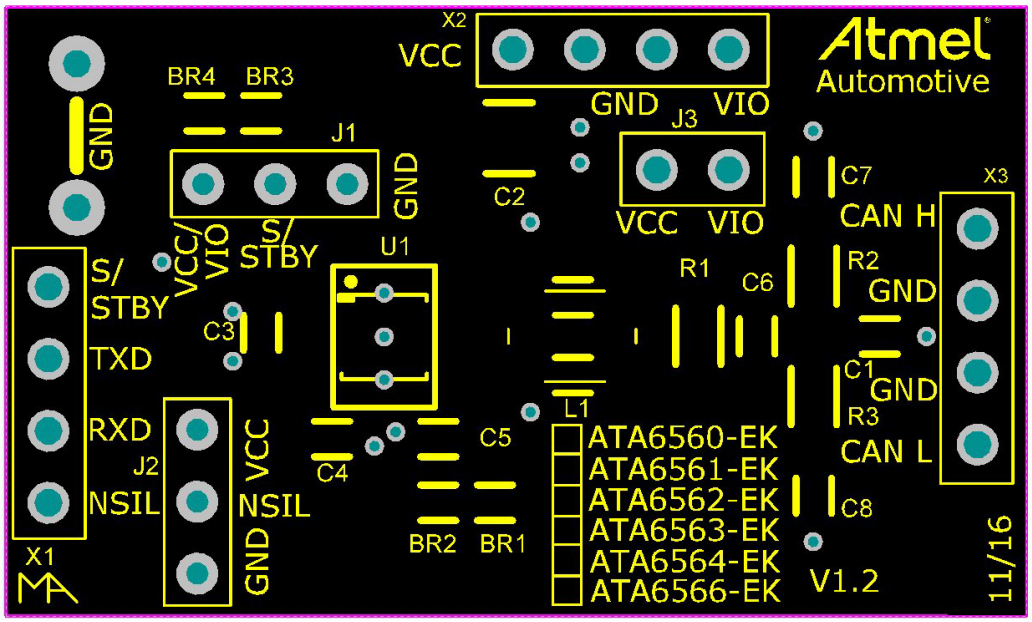
This appendix contains the following schematic and layouts for the ATA6560/1/2/3/4/6 Evaluation Kit:

- Board – Schematic
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Bottom Copper

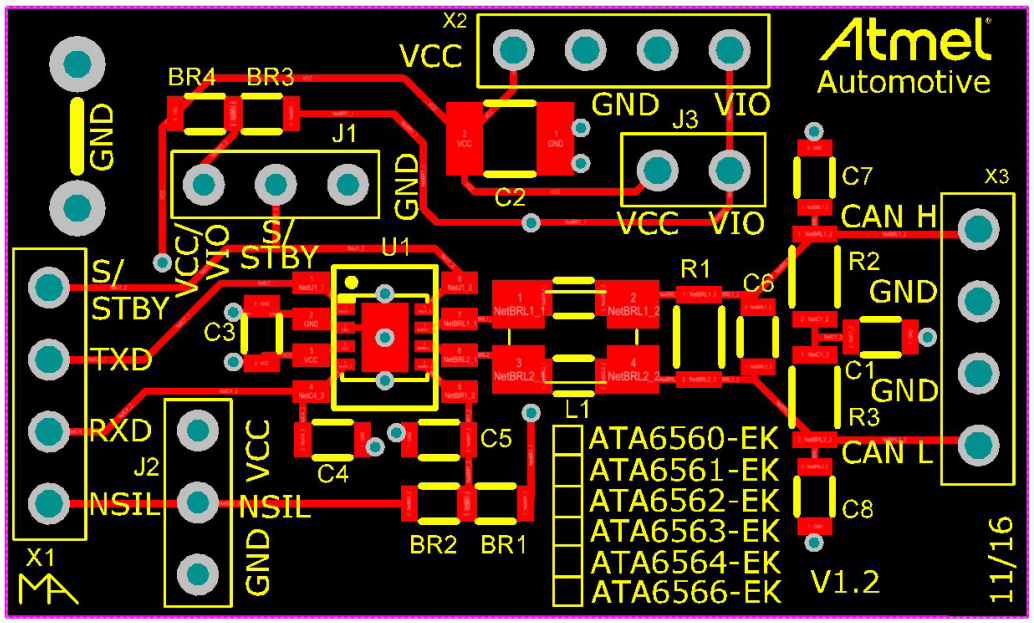
A.2 BOARD – SCHEMATIC



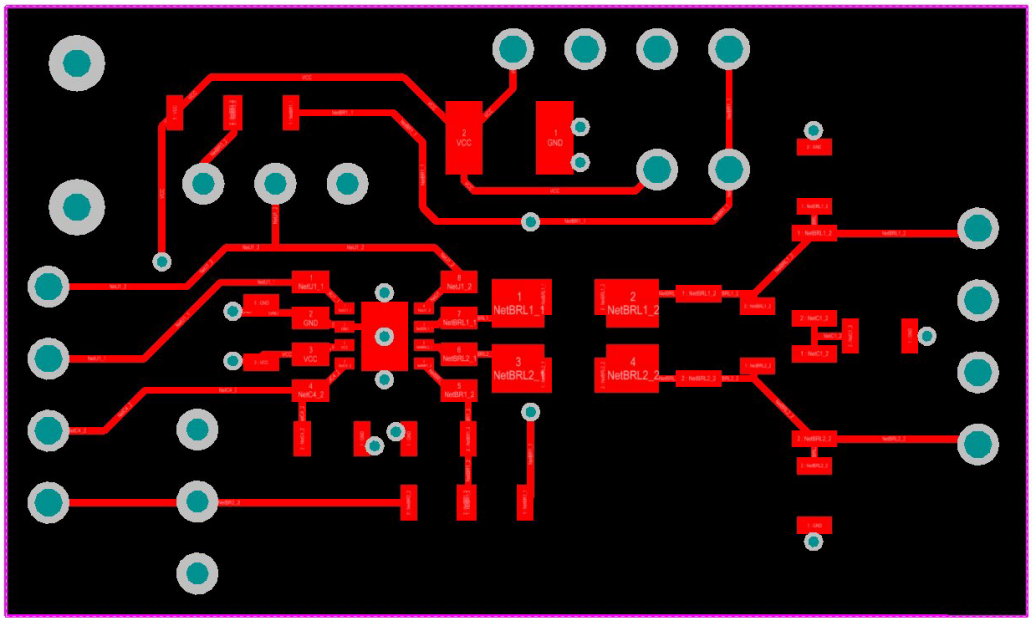
A.3 BOARD – TOP SILK



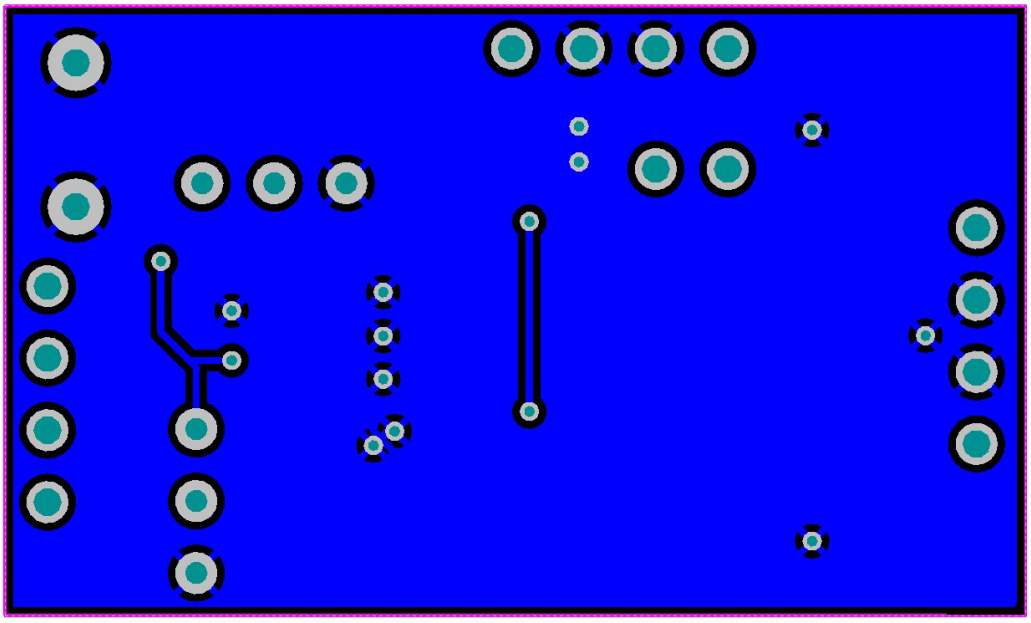
A.4 BOARD – TOP COPPER AND SILK



A.5 BOARD – TOP COPPER



A.6 BOARD – BOTTOM COPPER



Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM) FOR ATA6560 AND ATA6562 (PIN 5 = NSIL)

Part	Description	Part Size	Part value
X1	Header 1 x 4	1 x 4 2.54 mm	Header 1 x 4
X2	Header 1 x 2	1 x 2 2.54 mm	Header 1 x 2
X3	Header 1 x 4	1 x 4 2.54 mm	Header 1 x 4
J1	PCB jumper switch	1 x 3 2.54 mm	PCB jumper switch 1 x 3 2.54 mm
J2	PCB jumper switch	1 x 3 2.54 mm	PCB jumper switch 1 x 3 2.54 mm
C1	Capacitor	SMD 0805	4.7 nF/50V
C2	Capacitor	SMD 1210	47 µF/10V
C3	Capacitor	SMD 0805	100 nF
GND-shackle	Measuring bracket	GND-shackle	GND2
R2	resistor	SMD 1206	62Ω/0.5W
R3	resistor	SMD 1206	62Ω/0.5W
L1	Common mode choke	EPCOS B82799	EPCOS B82799 0Ω resistor 0805 between term. 1 and 2 and between term. 3 and 4
BR2	0Ω resistor	SMD 0805	0Ω
BR4	0Ω resistor	SMD 0805	0Ω
IC - SOIC8	CAN- transceiver	SOIC8	ATA6560-GAQW ATA6562-GAQW1
IC - VDFN8	CAN- transceiver	VDFN8	ATA6560-GBQW ATA6562-GBQW1

TABLE B-2: BILL OF MATERIALS (BOM) FOR ATA6561, ATA6563 AND ATA6566 (PIN 5 = VIO)

Part	Description	Part Size	Part value
X1	Header 1 x 3	1 x 3 2.54 mm	Header 1 x 3
X2	Header 1 x 4	1 x 4 2.54 mm	Header 1 x 4
X3	Header 1 x 4	1 x 4 2.54 mm	Header 1 x 4
J1	PCB jumper switch	1 x 3 2.54 mm	PCB jumper switch 1 x 3 2.54 mm
J3	Header 1 x 2	1 x 2 2.54 mm	Header 1 x 2
C1	Capacitor	SMD 0805	4.7 nF/50V
C2	Capacitor	SMD 1210	47 µF/10V
C3	Capacitor	SMD 0805	100 nF
C5	Capacitor	SMD 0805	100 nF
GND-shackle	Measuring bracket	GND-shackle	GND2
R2	resistor	SMD 1206	62Ω/0.5W
R3	resistor	SMD 1206	62Ω/0.5W
L1	Common mode choke	EPCOS B82799	EPCOS B82799 0Ω resistor 0805 between term. 1 and 2 and between term. 3 and 4
BR1	0Ω resistor	SMD 0805	0Ω
BR3	0Ω resistor	SMD 0805	0Ω
IC - SOIC8	CAN- transceiver	SOIC8	ATA6561-GAQW ATA6563-GAQW1 ATA6566-GAQW1
IC - VDFN8	CAN- transceiver	VDFN8	ATA6561-GBQW ATA6563-GAQW1 ATA6566-GBQW1

TABLE B-3: BILL OF MATERIALS (BOM) FOR ATA6564 (PIN 5 = VIO, PIN 8 = S)

Part	Description	Part Size	Part value
X1	Header 1 x 3	1 x 3 2.54 mm	Header 1 x 3
X2	Header 1 x 4	1 x 4 2.54 mm	Header 1 x 4
X3	Header 1 x 4	1 x 4 2.54 mm	Header 1 x 4
J1	PCB jumper switch	1 x 3 2.54 mm	PCB jumper switch 1 x 3 2.54 mm
J3	Header 1 x 2	1 x 2 2.54 mm	Header 1 x 2
C1	Capacitor	SMD 0805	4.7 nF/50V
C2	Capacitor	SMD 1210	47 µF/10V
C3	Capacitor	SMD 0805	100 nF
C5	Capacitor	SMD 0805	100 nF
GND-shackle	Measuring bracket	GND-shackle	GND2
R2	resistor	SMD 1206	62Ω/0.5W
R3	resistor	SMD 1206	62Ω/0.5W
L1	Common mode choke	EPCOS B82799	EPCOS B82799 0Ω resistor 0805 between term. 1 and 2 and between term. 3 and 4
BR1	0Ω resistor	SMD 0805	0Ω
BR3	0Ω resistor	SMD 0805	0Ω
IC - SOIC8	CAN- transceiver	SOIC8	ATA6564-GAQW1
IC - VDFN8	CAN- transceiver	VDFN8	ATA6564-GBQW1

NOTES:

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC
Tel: 919-844-7510

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-3326-8000
Fax: 86-21-3326-8021

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

France - Saint Cloud
Tel: 33-1-30-60-70-00

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-67-3636

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7289-7561

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820