Upgrading Note
TJA1053 ➔ TJA1054

V1.1

HAI/TR0011

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Summary

This report describes all items to be taken into account, if an existing application using the TJA1053 should be upgraded towards the TJA1054. Hardware issues as well as software issues are discussed.

Both transceiver, TJA1053 and TJA1054, are interoperable and can be used simultaneously within the same network. This allows migrating gradually from TJA1053 to TJA1054 in running car mass production.

Due to new features introduced with the TJA1054, existing TJA1053 applications need to be reviewed according to the comments within this report before replacing the transceiver.

Revision History

Version	Remarks
2nd of August 1999	V1.0 Initial Version
6th of April 2000	V1.0 -> V1.1 Chapter 3.3 : Behavioural difference after first battery connection / INH pin added Chapter 6 : Migration checklist, above mentioned item added

Contents

1. INTRODUCTION

The TJA1054 is a fault-tolerant CAN Transceiver suitable for networks including up to 32 nodes and is the compatible successor of the well-known TJA1053. Compared with the TJA1053, the TJA1054 provides several enhanced features:

- Extremely reduced electro-magnetic emission (EME)
- Very good electro-magnetic immunity (EMI)
- Enhanced bus failure management (short circuits to 5V are tolerated)
- Improved error signalling
- Improved behaviour during “Loss of Power” situations

The TJA1054 is designed to be downward compatible to the TJA1053 and can be used in most existing TJA1053 applications without any changes in hardware and software. Nevertheless, due to the enhanced functionality there are some points to be considered if the TJA1053 is replaced by the TJA1054.

The following chapters discuss all hardware and software issues in detail in order to allow a smooth migration from the TJA1053 to the TJA1054.

Special attention is paid to interoperability issues giving the confidence that both devices can be used simultaneously within one network. Validation showed that a “step-by-step” introduction of the TJA1054 into an existing TJA1053 system can be made without risk.

2. HARDWARE ISSUES

2.1 External Components

When the TJA1053 is replaced by a TJA1054, two external hardware components may be removed (see also figure 1) :

- Reverse current protection diode at BAT pin
- Pulse lengthening capacitor at ERR_ pin

The extra diode for the TJA1053 was needed to suppress a reverse power supply of the control unit if the battery connection of the entire unit was lost. For the TJA1053, a current flow from the CANL bus line backward to the BAT pin of the transceiver was possible if the transceiver was not powered. In some applications, this reverse current was high enough to supply the microcontroller erroneously. The TJA1054 is internally protected against such reverse currents making the diode obsolete.

Reading the ERR_ pin during the normal CAN interrupt service routine was not possible for the TJA1053 in case of “open failures” on the bus lines. Here, the so-called “acknowledge bit” of any valid CAN message cleared an already detected “open failure” at the ERR_ pin. Therefore, an external lengthening capacitor was required for the TJA1053 in order to keep the detected failure signal valid until the interrupt service routine was executed by the host uC.

The TJA1054 does not require this extra lengthening capacitor since the ERR_ pin now internally keeps the failure signal active.

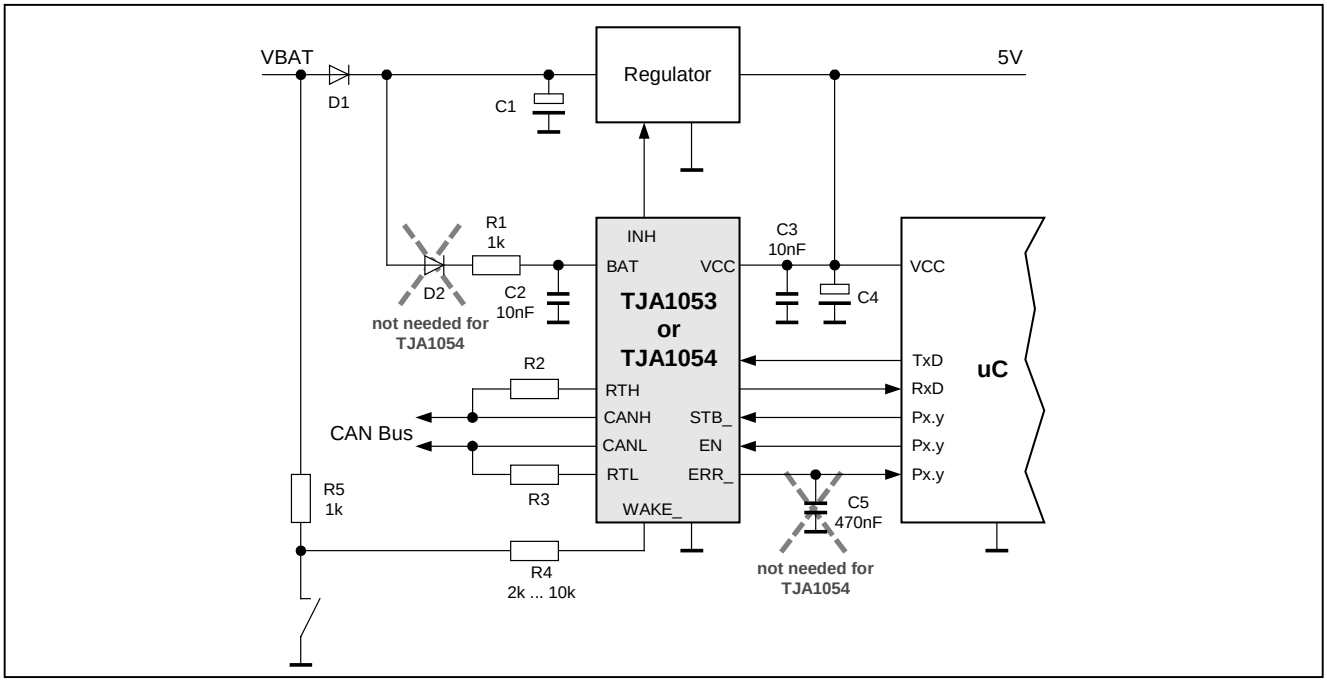

Figure 1 : Typical application circuitry using the TJA1053 and the TJA1054

2.2 Wake-up sensitivity at WAKE_ pin

The wake-up input of the TJA1054 is now sensitive on both edges, whereas the TJA1053 was sensitive on the falling edge only. This has typically no impact on the application since such external wake-up events are usually pulses including both edges.

Another improvement of the TJA1054 is that wake-up events have higher priority than the “Goto Sleep” command. Systems using the TJA1053 may lose such a wake-up event. Consequently, a TJA1053 node may keep sleeping without starting the voltage regulator although a wake-up request has been driven to the WAKE_ pin. The TJA1054 will now recognise any wake-up event independently from the current command setting of the host CPU.

2.3 Current consumption

The total current consumption of the TJA1054 is reduced compared to the TJA1053, especially during low-power modes. The slightly increased short circuit current of the CANH bus driver within the TJA1054 is compensated by its reduced normal mode supply current during dominant bus states. Thus, there is no impact to the applications power supply concept. But introduction of the TJA1054 provides a much lower sleep current per control unit now compared with the TJA1053.

Condition	**TJA1053**	**TJA1054**
Current consumption in Normal Mode, I_{CC}	6 mA recessive 29mA dominant	7 mA recessive 17mA dominant
Current consumption in Low-power Modes, $I_{BAT}+I_{CC}$	70uA	30uA

2.4 Operating Voltage Range

In order to increase the system performance during low battery conditions, the TJA1054 now allows operation down to 5V at the BAT pin, whereas the TJA1053 required at least 6V.

3. SOFTWARE ISSUES

3.1 Error signalling via ERR_ pin

As already mentioned before, the behaviour of the error signalling at the ERR_ pin is improved within the TJA1054. This allows removing the external lengthening capacitor needed for the TJA1053 (see also 2.1).

This new behaviour of the TJA1054 may have an impact on application software if the TJA1053 was used without external lengthening capacitor. Two scenarios are possible:

3.1.1 Software polls ERR_ pin

Application software polling the ERR_ pin will see fewer transitions if the TJA1053 is replaced by the TJA1054. Especially during "open failures" on the bus lines, the software load caused by ERR_ events is reduced if the TJA1054 is used.

3.1.2 Software reads ERR_ pin during CAN interrupt service only

Here, the "open failures" are now detected and signalled by the TJA1054 as desired, whereas the TJA1053 has signalled no problem. Thus, a simple migration to the TJA1054 automatically improves a software driven diagnosis function.

3.2 VCC Standby / PWON Standby

The VCC Standby Mode known from the TJA1053 is replaced by the so-called PWON Standby Mode in the TJA1054 (STB_ = 1; EN = 0). There is no change in functionality between both transceivers except for the CANL biasing level. The TJA1053 drives 5V to CANL, while the TJA1054 now drives 12V to CANL. This has no impact on the overall system performance if both transceivers are mixed in one network. Software is not influenced since both transceivers provide the same status information to the microcontroller via ERR_ and RXD.

3.3 First Battery Connection, INH pin behaviour

The TJA1053 allows to be set into Sleep Mode (INH floating) directly after first battery connection by driving the Goto Sleep Command to the control pins STB_ and EN ("01"). The TJA1054 needs to be set into Normal Mode before accepting the first Goto Sleep Command after first connection of the battery supply. After setting Normal Mode both devices behave identical concerning this item.

An internal power-on reset signal within the TJA1054 makes sure that the transceiver is reset successfully after power-up and the INH output is safely set to battery level. This internal reset signal is cleared whenever the Normal Mode is entered once. There are no special timing requirements to clear the internal reset signal thus software just has to set the Normal Mode via STB_ and EN followed by any other control code. Within most of the existing applications this is already implemented inside of the systems cold-start routines.

3.4 Other issues

Experience with different software drivers shows that it is of advantage to implement a kind of CAN communication monitoring in software, expecting CAN bus events in certain time frames. At least a reception of messages or successful transmissions should appear in order to get confidence, that the CAN bus is still operating properly. Otherwise there is a possible risk that a transmitting node blocks one CAN

bus wire due to missing acknowledges (continuous transmission), preventing the rest of the system from switching to the same wire.

Therefore, whenever there is no response from the CAN bus within a reasonable time, pending transmission requests should be aborted by software. This will increase the system availability during certain bus failure conditions, which require single wire operation.

4. INTEROPERABILITY : MIXED SYSTEMS WITH TJA1053 AND TJA1054

4.1 Overview

During development of the TJA1054 special attention was paid to interoperability issues in order to allow a smooth migration of existing applications by simple replacement of the TJA1053. Particularly, the enhancements of the bus failure management (5V short circuits) have been included very carefully into the existing circuitry to avoid system hang-ups, if both transceivers are mixed in one system.

The TJA1054 is designed to replace the TJA1053 within running car series production without interoperability risk.

Interoperability of both devices has been proved in system simulation as well as in hardware investigation.

The key results of these investigations are :

- A pure TJA1054 network solves the known weaknesses of a TJA1053 system (wake-up of big networks with failure HxGND, short circuits to 5V ....)
- A mixed system of TJA1053 and TJA1054 has at least the same performance as the pure TJA1053 system; in some aspects the growing presence of TJA1054 nodes in the network even improves the overall system performance
- Taking into consideration the issues described in the previous chapters, mixed systems of both transceiver are possible at any ratio without restrictions

4.2 Hardware Interoperability Investigations

In order to investigate interoperability issues of the transceiver, a network with 25 nodes was set up and investigated in detail. A typical topology including star points was chosen according to real automotive applications. This topology includes cable stubs with more than 5 meters and more than 55 meters overall cable length.

Worst case scenarios were analysed including weak bus failure conditions, double failures, ground shifts and power supply drops. Especially, operating mode changes (Normal Mode / Standby / Sleep) were performed simultaneously with bus failure situations.

4.3 Results of Hardware Interoperability Investigation

The following table gives an overview about the mixed system investigations using the TJA1053 together with the TJA1054 in different mixing ratios. An assessment is made compared with a pure TJA1053 system with same topology.

Bus Failure		Standard Communication (incl. resistive failures)	Communication with Ground Shift (+/- 1.5V)	Communication at Low Battery Voltages	Mode Changes / Wake-up combined with Bus Failure Conditions	Communication with local Loss of Termination
0	none	✓	✓	✓	✓	✓
1	H //	✓	✓	✓	☺	☺
2	L //	✓	✓	✓	✓	✓
3	HxBAT	☺	✓	✓	✓	✓
3a	HxVCC	☺	☺	☺	☺	☺
4	LxGND	✓	☺	✓	✓	✓
5	HxGND	✓	✓	✓	☺	✓
6	LxBAT	✓	☺	✓	✓	✓
6a	LxVCC	✓	✓	✓	☺	✓
7	HxL	✓	✓	✓	✓	✓

Key :

(☺) mixed system behaves better than a pure TJA1053 system
(✓) mixed system behaves equal to a pure TJA1053 system
(👎) mixed system behaves worse than a pure TJA1053 system

5. CONCLUSION

Both transceivers, TJA1053 and TJA1054, are interoperable and can be used simultaneously within the same network. This allows migrating gradually from TJA1053 to TJA1054 in running car mass production.

Due to new features introduced with the TJA1054, existing TJA1053 applications need to be reviewed according to the comments within this report before replacing the transceiver.

6. MIGRATION CHECKLIST

Item	TJA1053	TJA1054	Comment
Diode @ BAT pin	needed	can be removed	no reverse power supplying by TJA1054
Capacitor @ ERR_ pin	depends on software	can be removed	function is integrated into the TJA1054
Sensitivity WAKE_ pin	falling edge only	both edges	check behaviour of system wake-up via WAKE_ pin
Goto Sleep command after first battery connection	always possible	possible only after Normal Mode was entered once	Internal power-on signal has to be cleared by setting the transceiver into Normal Mode after first battery connection