

# TPMS

Tire Pressure Monitoring Sensor

## SP37

### Application Note

LF Duty Cycle Measurement  
Revision 1.0, 2011-10-11

**Edition 2011-12-07**

**Published by  
Infineon Technologies AG  
81726 Munich, Germany**

**© 2011 Infineon Technologies AG  
All Rights Reserved.**

#### **LEGAL DISCLAIMER**

THE INFORMATION GIVEN IN THIS APPLICATION NOTE IS GIVEN AS A HINT FOR THE IMPLEMENTATION OF THE INFINEON TECHNOLOGIES COMPONENT ONLY AND SHALL NOT BE REGARDED AS ANY DESCRIPTION OR WARRANTY OF A CERTAIN FUNCTIONALITY, CONDITION OR QUALITY OF THE INFINEON TECHNOLOGIES COMPONENT. THE RECIPIENT OF THIS APPLICATION NOTE MUST VERIFY ANY FUNCTION DESCRIBED HEREIN IN THE REAL APPLICATION. INFINEON TECHNOLOGIES HEREBY DISCLAIMS ANY AND ALL WARRANTIES AND LIABILITIES OF ANY KIND (INCLUDING WITHOUT LIMITATION WARRANTIES OF NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF ANY THIRD PARTY) WITH RESPECT TO ANY AND ALL INFORMATION GIVEN IN THIS APPLICATION NOTE.

#### **Information**

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office ([www.infineon.com](http://www.infineon.com)).

#### **Warnings**

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

Infineon Technologies components may be used in life-support devices or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.



confidential

**Revision History**

Page or Item	Subjects (major changes since previous revision)
<b>Revision 1.0, 2011-10-11</b>	

**Trademarks of Infineon Technologies AG**

AURIX™, C166™, CanPAK™, CIPOS™, CIPURSE™, EconoPACK™, CoolMOS™, CoolSET™, CORECONTROL™, CROSSAVE™, DAVE™, EasyPIM™, EconoBRIDGE™, EconoDUAL™, EconoPIM™, EiceDRIVER™, eupec™, FCOS™, HITFET™, HybridPACK™, I<sup>2</sup>RF™, ISOFACE™, IsoPACK™, MIPAQ™, ModSTACK™, my-d™, NovalithIC™, OptiMOS™, ORIGA™, PRIMARION™, PrimePACK™, PrimeSTACK™, PRO-SIL™, PROFET™, RASIC™, ReverSave™, SatRIC™, SIEGET™, SINDRION™, SIPMOS™, SmartLEWIS™, SOLID FLASH™, TEMPFET™, thinQ!™, TRENCHSTOP™, TriCore™.

**Other Trademarks**

Advance Design System™ (ADS) of Agilent Technologies, AMBA™, ARM™, MULTI-ICE™, KEIL™, PRIMECELL™, REALVIEW™, THUMB™, μVision™ of ARM Limited, UK. AUTOSAR™ is licensed by AUTOSAR development partnership. Bluetooth™ of Bluetooth SIG Inc. CAT-iq™ of DECT Forum. COLOSSUS™, FirstGPS™ of Trimble Navigation Ltd. EMV™ of EMVCo, LLC (Visa Holdings Inc.). EPCOS™ of Epcos AG. FLEXGO™ of Microsoft Corporation. FlexRay™ is licensed by FlexRay Consortium. HYPERTERMINAL™ of Hilgraeve Incorporated. IEC™ of Commission Electrotechnique Internationale. IrDA™ of Infrared Data Association Corporation. ISO™ of INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. MATLAB™ of MathWorks, Inc. MAXIM™ of Maxim Integrated Products, Inc. MICROTEC™, NUCLEUS™ of Mentor Graphics Corporation. Mifare™ of NXP. MIPI™ of MIPI Alliance, Inc. MIPS™ of MIPS Technologies, Inc., USA. muRata™ of MURATA MANUFACTURING CO., MICROWAVE OFFICE™ (MWO) of Applied Wave Research Inc., OmniVision™ of OmniVision Technologies, Inc. Openwave™ Openwave Systems Inc. RED HAT™ Red Hat, Inc. RFMD™ RF Micro Devices, Inc. SIRIUS™ of Sirius Satellite Radio Inc. SOLARIS™ of Sun Microsystems, Inc. SPANSION™ of Spansion LLC Ltd. Symbian™ of Symbian Software Limited. TAIYO YUDEN™ of Taiyo Yuden Co. TEAKLITE™ of CEVA, Inc. TEKTRONIX™ of Tektronix Inc. TOKO™ of TOKO KABUSHIKI KAISHA TA. UNIX™ of X/Open Company Limited. VERILOG™, PALLADIUM™ of Cadence Design Systems, Inc. VLYNQ™ of Texas Instruments Incorporated. VXWORKS™, WIND RIVER™ of WIND RIVER SYSTEMS, INC. ZETEX™ of Diodes Zetex Limited.

Last Trademarks Update 2011-02-24

## Table of Contents

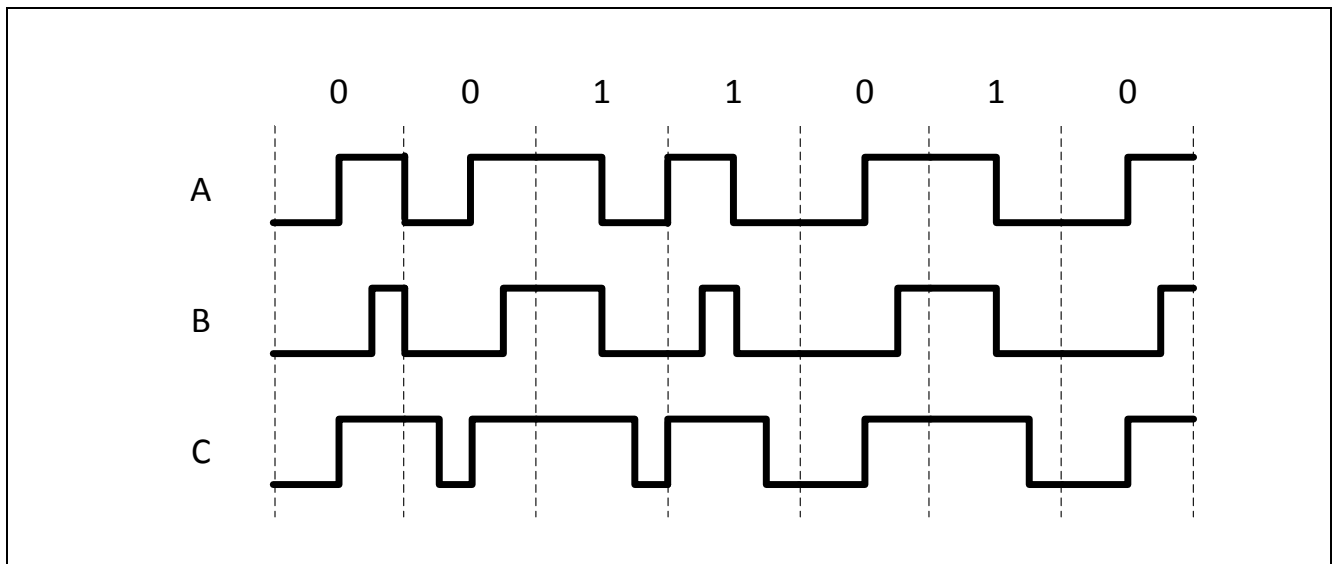
1	Introduction .....	5
2	Measurement setup .....	6
3	Measurement results .....	7

## List of Figures

Figure 1	Manchester encoded signal. A: ideal signal, B: decreased duty cycle, C: increased duty cycle.....	5
Figure 2	Measurement setup .....	6
Figure 3	Circuit for generating edge delay. S1 in position I: falling edge delayed, S1 in position II: rising edge delayed.....	6
Figure 4	Error rate versus duty cycle .....	7

## 1 Introduction

Apart from other timing parameters like baud rate the LF-telegram must comply with duty cycle requirements. For a periodic rectangular signal duty cycle is defined as ratio of high-time to signal period. However, the LF telegram is a non periodic, Manchester encoded binary signal. In fact both, the high time and low time, can be half the bit time or full bit time, depending on transmitted bit pattern (see curve A in Figure 1). Therefore for this kind of signal the duty cycle is changed by delaying all rising or all falling edges of the telegram by a constant delay time. As a result the relative change of the short high periods is greater than of the long high periods. Hence the duty cycle is defined as the ratio of the shortest high period and the bit time.



**Figure 1** Manchester encoded signal. A: ideal signal, B: decreased duty cycle, C: increased duty cycle

Figure 1 illustrates the definition of duty cycle. Case A is the ideal signal. The shortest high period is half the bit time. Hence the duty cycle is 50%. For case B all rising edges have been delayed by one quarter of the bit time. So the shortest high period is one quarter of the bit time. Therefore the duty cycle is 25%. Finally, in case C all falling edges have been delayed by one quarter of the bit time. The shortest high period is three quarter of a bit time. Hence in case C duty cycle is 75%.

## 2 Measurement setup

In the test setup the telegrams were generated by PC software. A 125 kHz carrier was modulated with this digital signal using the Agilent 33250A function generator. Since the used software could only provide Manchester encoded telegrams with a 50% duty cycle, a circuit for delaying either the rising edges or the falling edges was built between PC and function generator. Figure 2 shows the measurement setup and Figure 3 the circuit for generating the edge delay.

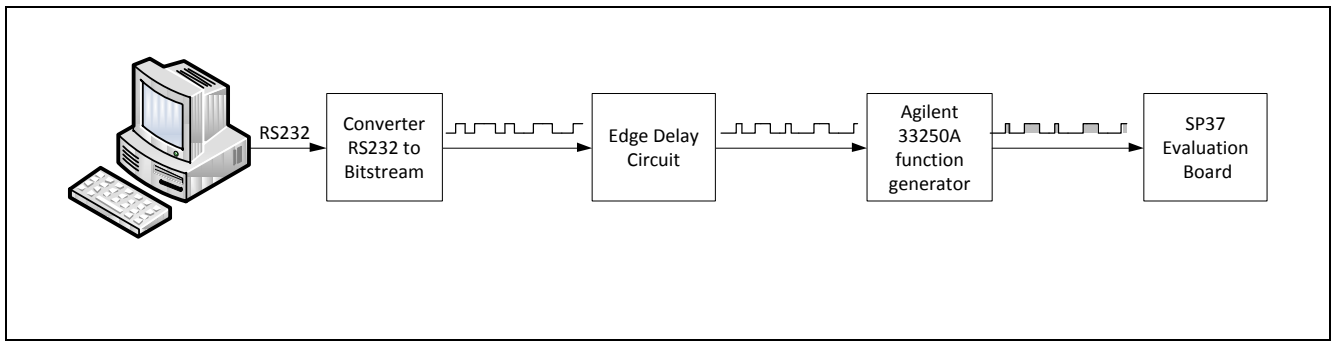


Figure 2 Measurement setup

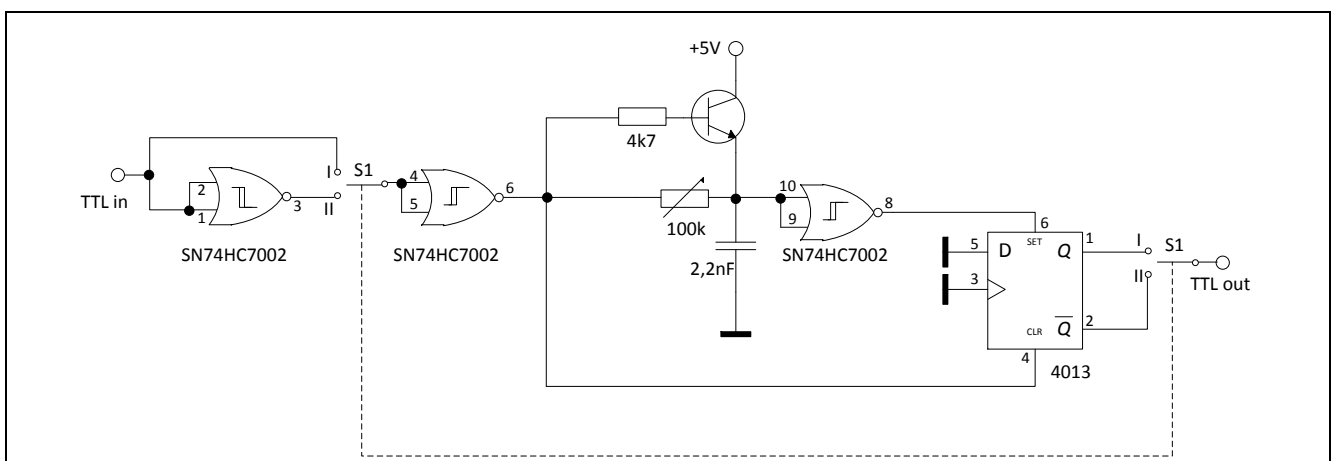
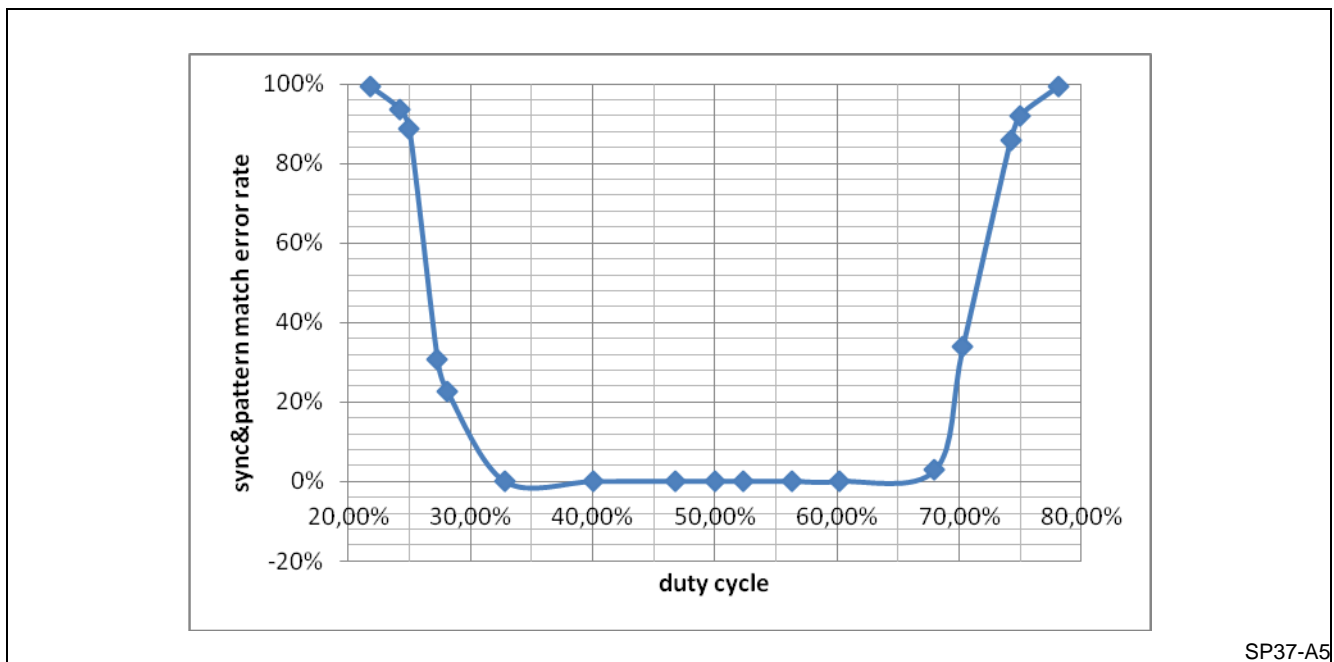


Figure 3 Circuit for generating edge delay. S1 in position I: falling edge delayed, S1 in position II: rising edge delayed.

### 3 Measurement results

The error rate versus duty cycle was determined by counting the number of detected matching events (matching of sync and P0 pattern) per time when periodically transmitting wakeup telegrams. The result is shown in Figure 4. For safe operation the duty cycle should stay in the interval of 40% to 60%. Anyhow, it is recommended to design the LF transmitter for a duty cycle of 50%.



SP37-A5

Figure 4 Error rate versus duty cycle

[www.infineon.com](http://www.infineon.com)

Published by Infineon Technologies AG