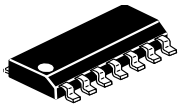
Document Number: MC33199
Rev. 4.0, 10/2006

Automotive ISO 9141 Serial Link Driver

33199

LIN, ISO-9141 J-1850 PHYSICAL INTERFACES



D SUFFIX
EF SUFFIX (PB-FREE)
PLASTIC PACKAGE
98ASB42565B
14 PIN SOIC

The MC33199 is a serial interface circuit used in diagnostic applications. It is the interface between the microcontroller and the special K and L lines of the ISO diagnostic port. The MC33199 has been designed to meet the «Diagnosis System ISO9141» specification.

The device has a bi-directional bus K line driver, fully protected against short circuits and over temperature. It also includes the L line receiver, used during the wake up sequence in the ISO transmission.

The MC33199 has a unique feature which allow transmission Baud rate up to 200kBaud.

Features

- Electrically Compatible with Specification “Diagnosis System ISO9141”
- Transmission speed up to 200kBaud
- Internal Voltage Reference Generator for Line Comparator Thresholds
- TXD, RXD and LO pins are 5V CMOS Compatible
- High Current Capability of DIA pin (K line)
- Short Circuit Protection for the K Line Input
- Over Temperature Shutdown with Hysteresis
- Large Operating Range of Driver Supply Voltage
- Large Operating Temperature Range
- ESD Protected pins
- Pb-Free Packaging Designated by Suffix Code EF

ORDERING INFORMATION

Device	Temperature Range (T_A)	Package
MC33199D	-40°C to 125°C	14 SOIC
MCZ33199EF/R2		

ARCHIVE INFORMATION

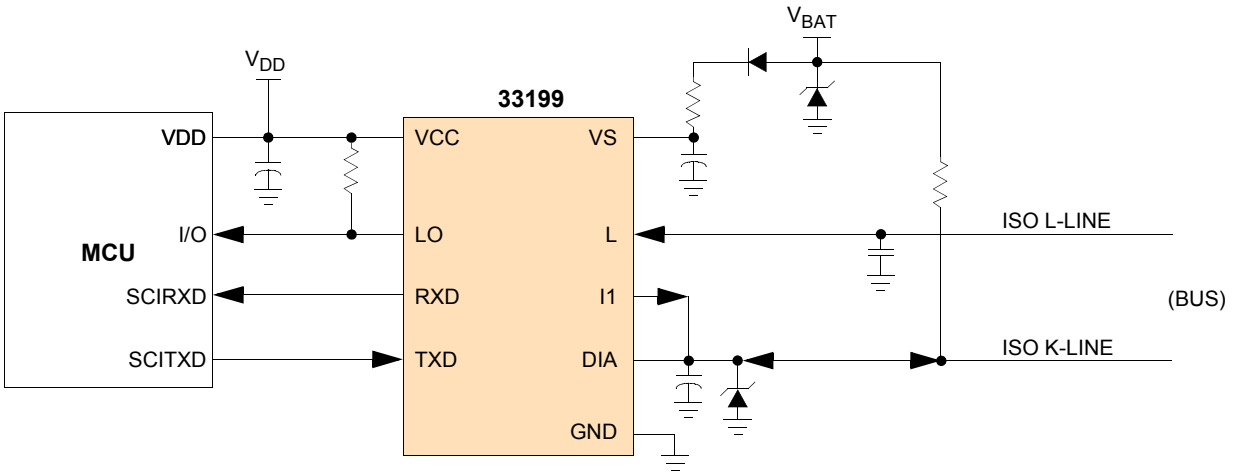


Figure 1. Simplified Application Diagram

INTERNAL BLOCK DIAGRAM

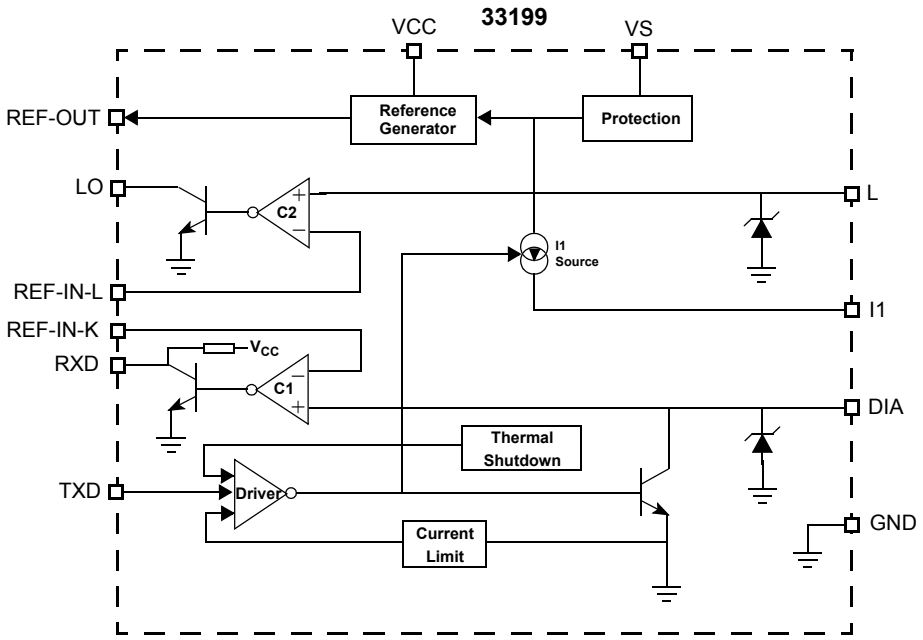


Figure 2. 33199 Simplified Internal Block Diagram

PIN CONNECTIONS

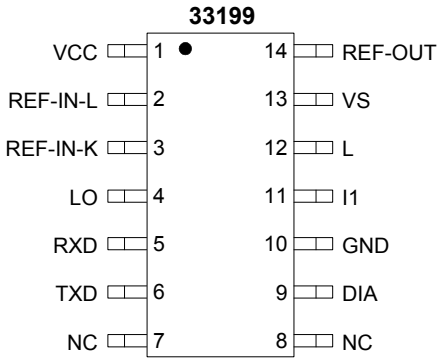


Figure 3. 33199 Pin Connections

Table 1. Pin Definitions

A functional description of each pin can be found in the Functional Pin Description section, beginning on page 12.

Pin Number	Pin Name	Definition
1	VCC	5V typical power supply pin. typical supply current is less than 1.5mA
2	REF-IN-L	Input reference for C2 comparator.
3	REF-IN-K	Input reference for C1 comparator.
4	LO	This pin control Sleep Mode, Transmit Level, and Speed. It has a weak pulldown.
5	RXD	Open drain output of the data on BUS. A recessive bus = a logic [1], a dominant bus = logic [0]. An external pullup is required.
6	TXD	Data input here will appear on the BUS pin. A logic [0] will assert the bus, a logic [1] will make the bus go to the recessive state.
7, 8	NC	No internal connection to these pins.
9	DIA	Provides a battery-level logic signal.
10	GND	Electrical Common Ground and Heat removal. A good thermal path will also reduce the die temperature.
11	I1	Power input. An external diode is needed for reverse battery protection.
12	L	The external bus load resistor connects here to prevent bus pullup in the event of loss of module ground.
13	VS	This pin connects to the bus through external components.
14	REF-OUT	Internal reference voltage generator output pin.

ARCHIVE INFORMATION

ELECTRICAL CHARACTERISTICS

MAXIMUM RATINGS

Table 2. Maximum Ratings

All voltages are with respect to ground unless otherwise noted. Exceeding these ratings may cause a malfunction or permanent damage to the device.

Ratings	Symbol	Value	Unit
ELECTRICAL RATINGS [1]			
VS Supply Pin			V
DC Voltage Range	V_S	0.5 to + 40	
Transient Pulse [2]	V_{PULSE}	2 to + 40	
VCC Supply DC Voltage Range	V_{CC}	0.3 to + 6.0	V
DIA and L Pins [2]			
DC Voltage Range		- 0.5 TO + 38	V
Transient Pulse (clamped by internal diode)		-2	V
DC Source Current		- 50	mA
DIA Low Level Sink Current		INT. LIMIT	mA
TXD DC Voltage Range		-0.3 TO V_{CC} +0.3	V
REF-IN DC Voltage Range			V
VS < VCC		-0.3 TO V_{CC}	
VS > VCC		-0.3 TO V_S	
ESD Voltage Capability	V_{ESD}	+/-2000	V
THERMAL RATINGS			
Storage Temperature	T_{STG}	55 to + 150	°C
Operating Junction Temperature	T_J	40 to + 150	°C
Thermal Resistance, Junction to air	R_{TJA}	180	C/W
Max Power Dissipation (@ T_A=105 °C)	P_D	250	mW
Peak Package Reflow Temperature During Reflow [3], [4]	T_{PPRT}	Note 4.	°C

Notes

1. The device is compatible with Specification: “Diagnosis System ISO9141”
2. See the test Circuit (Figure 26). Transient test pulse according to ISO76371 and DIN 40839, highest test levels
3. Pin soldering temperature limit is for 10 seconds maximum duration. Not designed for immersion soldering. Exceeding these limits may cause malfunction or permanent damage to the device.
4. Freescale’s Package Reflow capability meets Pb-free requirements for JEDEC standard J-STD-020C. For Peak Package Reflow Temperature and Moisture Sensitivity Levels (MSL),
Go to www.freescale.com, search by part number [e.g. remove prefixes/suffixes and enter the core ID to view all orderable parts. (i.e. MC33xxxD enter 33xxx), and review parametrics.

ARCHIVE INFORMATION

STATIC ELECTRICAL CHARACTERISTICS

Table 3. Static Electrical Characteristics

Characteristics noted under conditions V_{CC} from 4.5V to 5.5V, V_S from 4.5V to 20V unless otherwise note. Typical values reflect approximate mean at 25°C, nominal VCC and VS, at time of device characterization. Typical values noted reflect the approximate parameter means at T_A = 25°C under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
VCC PIN 1					
VCC Supply Voltage Range	V_{CC}	4.5		5.5	V
VCC Supply Current (6)	I_{CC}	0.5	1.0	1.5	V
REF-IN-L PIN 2 AND REF-IN-K PIN 3					
REF-IN-L & REF-IN-K Input Voltage Range: for 0 <V_S< V_{CC} for V_{CC} <V_S< 40V	V_{INREF}	 2.0 2.0		 V_{CC} -2.0 V_S -1.0	V
REF-IN-L & REF-IN-K Inputs Currents	I_{VIN}	-5.0		5.0	µA
LO PIN 4					
LO open Collector Output Low Level Voltage @ I_{OUT} = 1mA Low Level Voltage @ I_{OUT} = 4mA	V_{OL}		 0.34	 0.7 0.8	V
RXD PIN 5					
Pull up resistor to VCC	R_{RXD}	1.5	2.0	2.5	kΩ
Low Level Voltage @ I_{OUT}=1mA	V_{OL}		0.3	0.7	V
TXD PIN 6					
High Level Input Voltage	V_{IH}	0.7V_{CC}	2.8		V
Low Level Input Voltage	V_{IL}		2.0	0.3V_{CC}	V
Input Current @ 0<V_S<40V TXD at High Level TXD at Low Level	 I_H I_I	 -200 -600		 30 -100	µA
DIA INPUT / OUTPUT PIN 9					
Low Level Output Voltage @ I = 30mA	V_{OL}	0.0	0.35	0.8	V
Drive Current Limit	I_{LIM}	40		120	mA
High Level Input Threshold Voltage (REF-IN-K connected to REF-OUT)	V_{IH}	$V_{REF\ MIN}$ 0.25V	V_{REF} 0.325V	$V_{REF\ MAX}$ 0.4V	V
Low Level Input Threshold Voltage (REF-IN-K connected to REF-OUT)	V_{IL}	$V_{REF\ MIN}$ -0.2V	V_{REF} -0.125V	$V_{REF\ MAX}$ -0.05V	V
Input Hysteresis	V_{HYST}	300	450	600	mV
Leakage Current	I_{LEAK}	4.0	10	16	µA
Over temperature Shutdown	T_{LIM}	155			°C

Notes

5. Measured with TXD=Vcc, I1=Vs, DIA & L high, no load, REF-IN-L and REF-IN-K connected to REF-OUT

ARCHIVE INFORMATION

Table 3. Static Electrical Characteristics (continued)

Characteristics noted under conditions V_{CC} from 4.5V to 5.5V, V_S from 4.5V to 20V unless otherwise note. Typical values reflect approximate mean at 25°C, nominal VCC and VS, at time of device characterization. Typical values noted reflect the approximate parameter means at T_A = 25°C under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
L INPUT PIN 12					
High Level Input Threshold Voltage (REF-IN-L connected to REF-OUT)	V_{IH}	$V_{REF\ MIN}$ 0.25V	V_{REF} 0.325V	$V_{REF\ MAX}$ 0.4V	V
Low Level Input Threshold Voltage (REF-IN-L connected to REF-OUT)	V_{IL}	$V_{REF\ MIN}$ -0.2V	V_{REF} -0.125V	$V_{REF\ MAX}$ -0.05V	V
Input Hysteresis	V_{HYST}	300	450	600	mV
Leakage Current	I_{LEAK}	4.0	10	16	µA
L1 INPUT PIN 11					
Static Source Current	I_{1S}	-4.0	-3.0	-2.0	mA
Static Saturation Voltage @ I1S=-2mA	V_{I1SAT}	V_S - 1.2	V_S - 0.8	V_S	V
Dynamic Source Current	I_{1D}	-120	-80	-40	mA
Dynamic Saturation Voltage @ I1S=-40mA	V_{I1DSAT}	V_S - 2.7	V_S - 0.85	V_S	V
VS PIN 13					
VS Supply Voltage Range	V_S	4.5		20	V
VS Supply Current	I_S	0.5	1.3	2.0	mA
REF-OUT PIN 14					
Output Voltage : @ 3 < V_S < 5.6V & IRO = +-10µA @ 5.6 < V_S < 18V & IRO = +-10µA @ 18 < V_S < 40V & IRO = +-10µA	V_{REF}	 2.7 0.5 x V_S 8.5		 3.3 0.56 x V_S 10.8	V
Maximum output current	I_{OUT}	-50		50	µA
Pull-up resistor to VCC	R_{PU}	3.0	8.0	12	kΩ

6. Measured with TXD=VCC, I1=VS, DIA & L high, no load, REF-IN-L and REF-IN-K connected to REF-OUT

ARCHIVE INFORMATION

DYNAMIC ELECTRICAL CHARACTERISTICS

Table 4. Dynamic Electrical Characteristics

Characteristics noted under conditions Vcc from 4.5V to 5.5V, Vs from 4.5V to 20V unless otherwise noted. Typical values noted reflect the approximate parameter means at T_A = 25°C under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
DELAY TIMING					
Transmission Speed	1/T BIT	0.0		200k	Baud
High or Low Bit Time	T BIT	5.0			µs
Rxd Output :					ns
Low to High Transition Delay Time	t_{RDR}			450	
High to Low Transition Delay Time	t_{DRF}			450	
LO Output :					µs
Low to High Transition Delay Time	t_{LDR}			2.0	
High to Low Transition Delay Time	t_{LDF}			2.0	
DIA Output :					ns
Low to High Transition Delay Time	t_{DDR}			650	
High to Low Transition Delay Time	t_{DDF}			650	
I1 Output @ VS-I1 > 2.7V :					µs
Rise time	t_{I1R}			0.3	
Hold Time	t_{I1F}	1.5		4.5	

ARCHIVE INFORMATION

TIMING DIAGRAMS

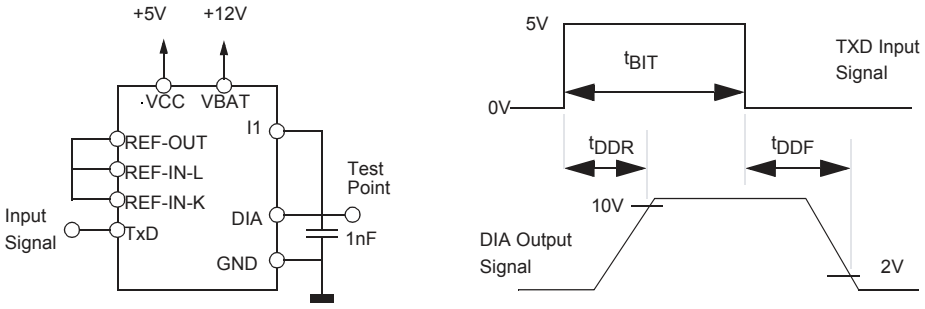


Figure 4. TXD to DIA AC Characteristic

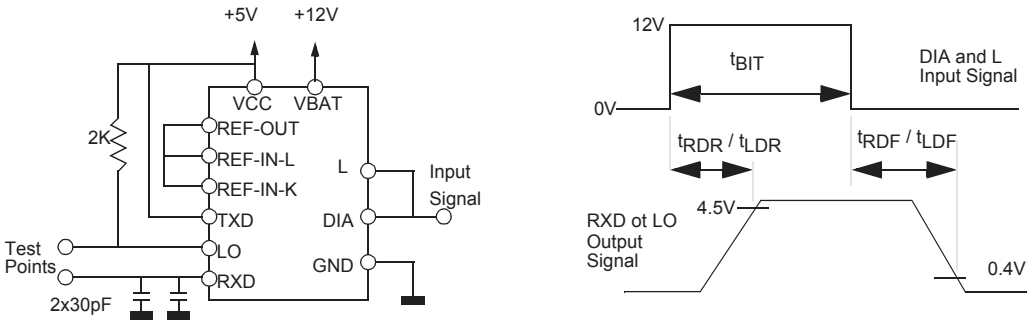


Figure 5. DIA to TxD and L to LO AC Characteristics

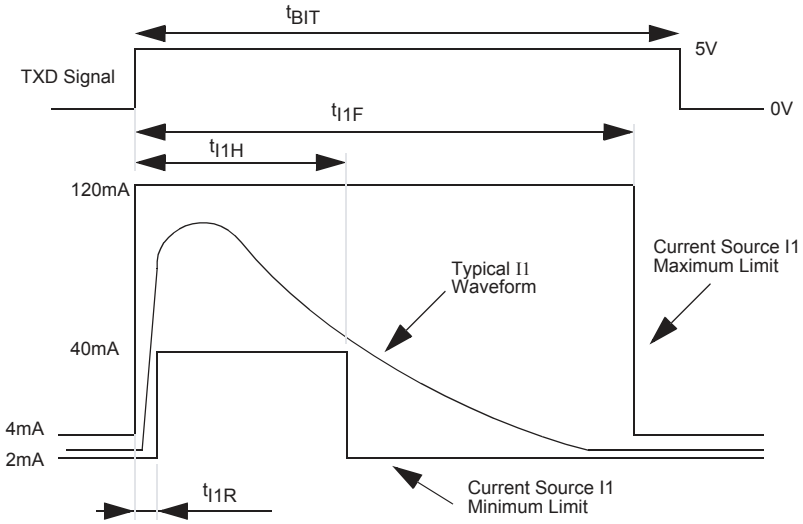


Figure 6. Current Source I1 AC Characteristics

At static HIGH or LOW level TXD, the current source I1 delivers a current of 3mA (typ). Only during LOW to HIGH transition, does this current increase to a higher value in order to charge the K Line capacitor (Cl<4nF) in a short time.

ARCHIVE INFORMATION

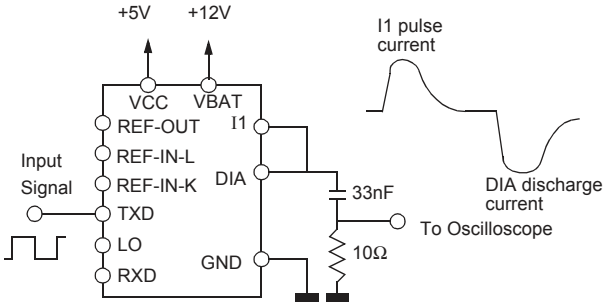


Figure 7. Current Source I1 and DIA Discharge current test schematic

ELECTRICAL PERFORMANCE CURVES

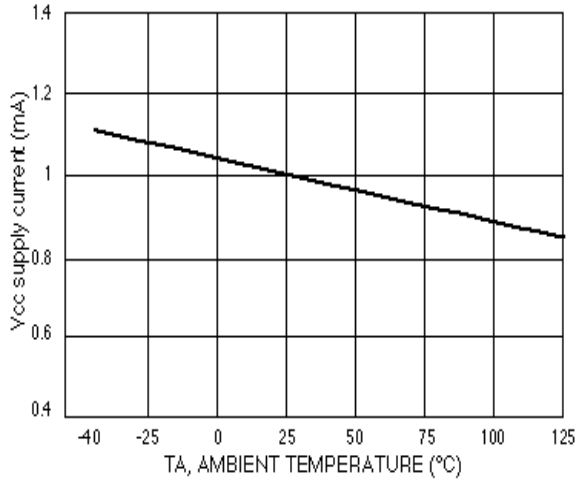


Figure 8. ICC Supply Current versus Temperature

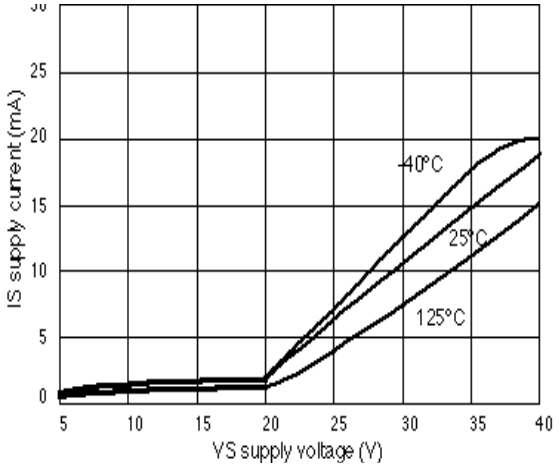


Figure 10. IS Supply Voltage versus VS Supply Voltage

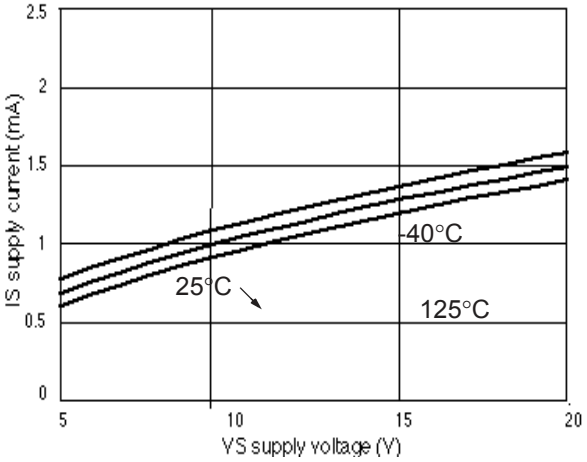


Figure 9. VS Supply Current versus VS Supply Voltage

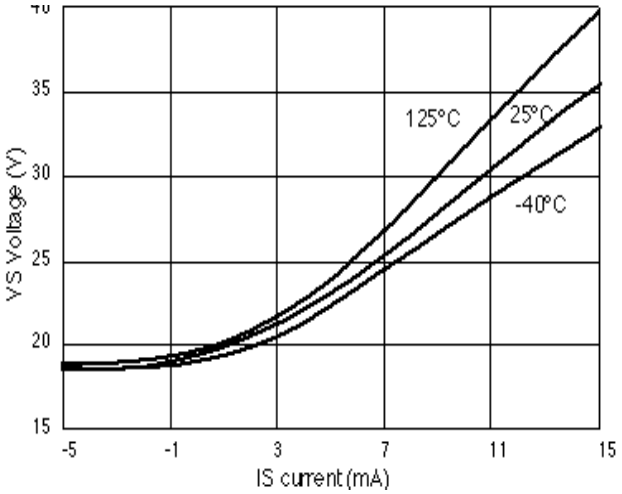


Figure 11. VS Voltage versus IS Current (V_{CC}=5.5V, V_{DIA}, L, I1=20V

ARCHIVE INFORMATION

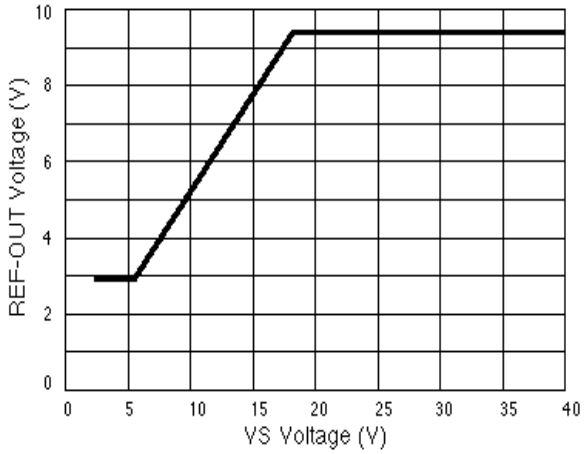


Figure 12. REF-OUT Voltage versus VS Supply Voltage

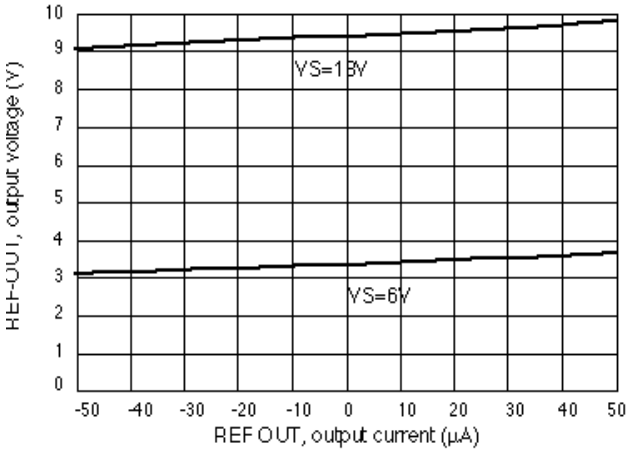


Figure 13. REF-OUT Voltage versus REF-OUT Current

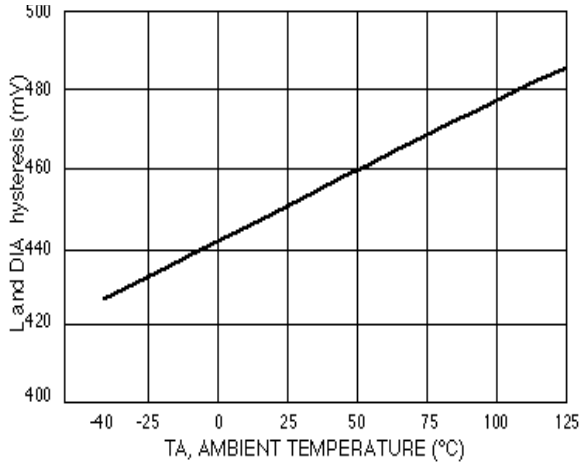


Figure 14. L and DIA Hysteresis versus Temperature

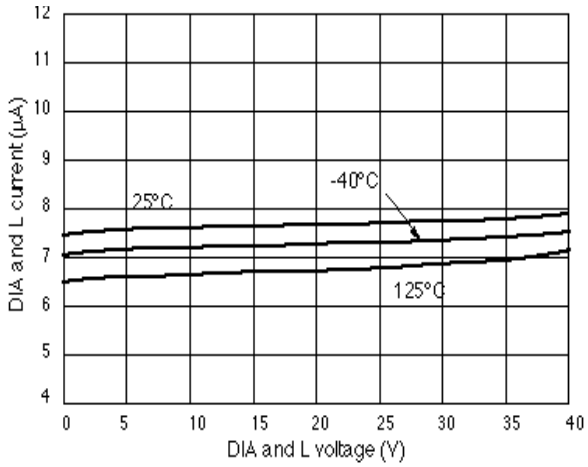


Figure 15. L and DIA Current versus L and DIA Voltage

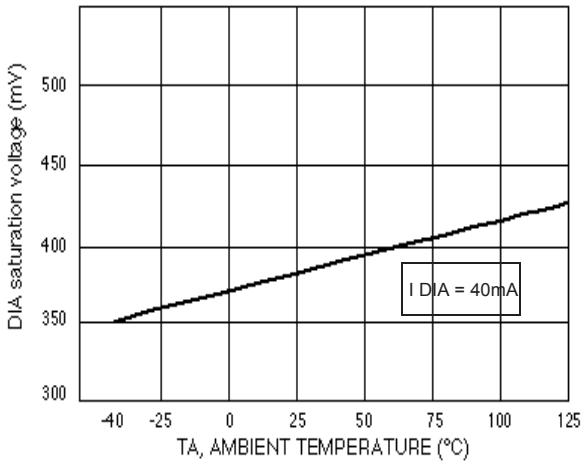


Figure 16. DIA Saturation Voltage versus Temperature

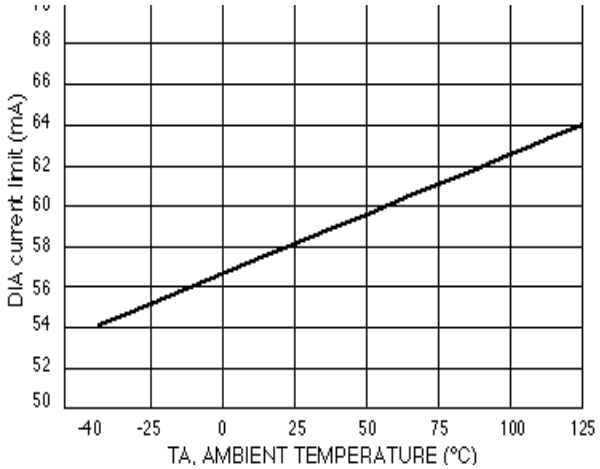


Figure 17. DIA Current Limit versus Temperature

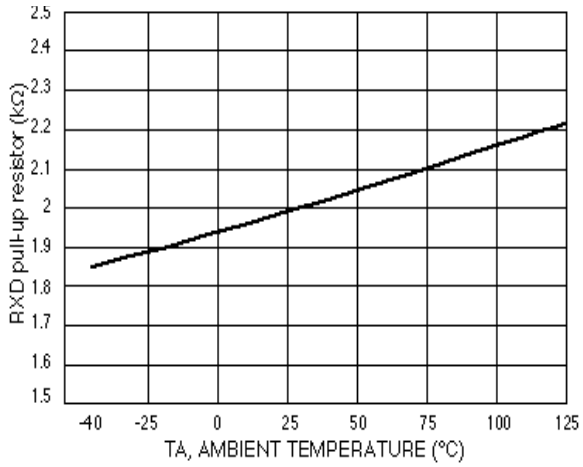


Figure 18. RXD Pull-up Resistor versus Temperature

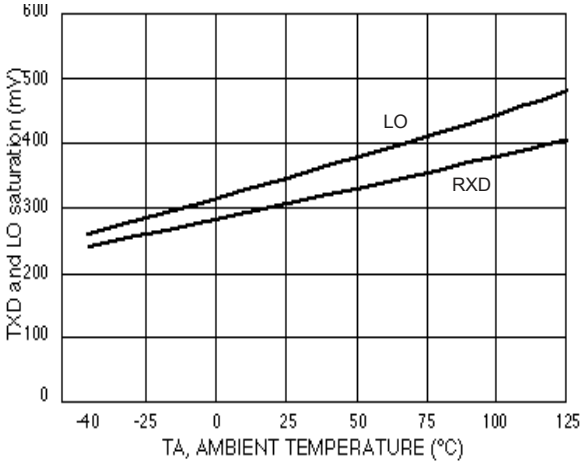


Figure 19. TXD and LO Saturation Voltage versus Temperature

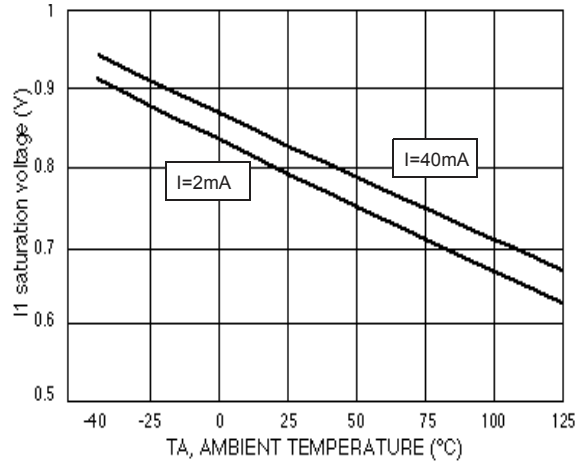


Figure 20. I1 Saturation Voltage versus Temperature

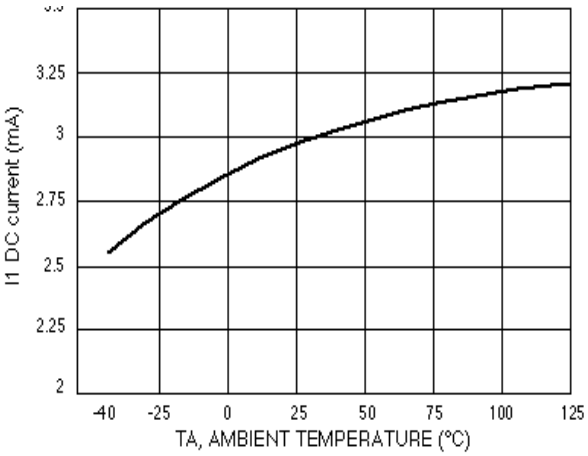


Figure 21. I1 Output DC Current versus Temperature

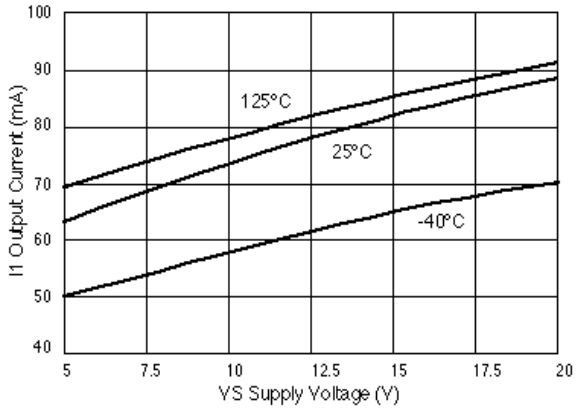


Figure 22. I1 Output Pulse Current versus VS Supply Voltage

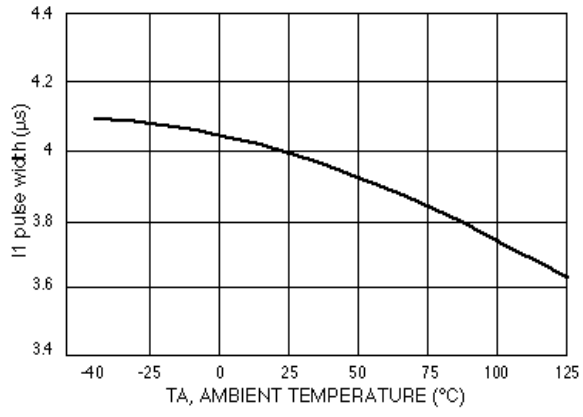


Figure 23. I1 Pulse Current Width versus Temperature

FUNCTIONAL DESCRIPTION

INTRODUCTION

The MC33199 is a serial interface circuit used in diagnostic applications. It is the interface between the microcontroller and the special K and L lines of the ISO diagnostic port. The MC33199 has been designed to meet the «Diagnosis System ISO9141» specification.

This product description will detail the functionality of the device (see Figure 2, 33199 Simplified Internal Block Diagram). First, the power supply and reference voltage generator will be discussed, then the paths functions between MCU, K and L lines will be detailed. A dedicated paragraph will tell about the special functionality of the I1 pin, which allow high Baud rates transmission.

FUNCTIONAL PIN DESCRIPTION

VCC (VCC)

5V typical power supply pin. Typical supply current is less than 1.5mA.

REF-IN-L (REF-IN-L)

Input reference for C2 comparator. This input can be connected directly to REF-OUT, with or without a resistor network, or to an external reference.

REF-IN-K (REF-IN-K)

Input reference for C1 comparator. This input can be connected directly to REF-OUT, with or without a resistor network, or to an external reference.

LO (LO)

Output of C2 comparator, normally connected to a micro-controller I/O. If L input > (REF-IN-L + Hyst/2) then output LO is in high state. If L< (REF-IN-L - Hyst/2) then output LO is in low state, output transistor ON.

This pin is an open collector structure. A Pull up resistor should be added to VCC.

Drive capability of this output is 5mA.

RXD (RXD)

Receive output, normally connected to a microcontroller I/O.

If DIA input > (REF-IN-L + Hyst/2) then output LO is in high state.

If DIA < (REF-IN-L - Hyst/2) then output LO is in low state, output transistor ON. This pin has an internal pull up resistor to VCC (2Kohm typ). Drive capability of this output is 5mA

TXD (TXD)

Transmission input, is normally connected to a microcontroller I/O.This pin controls DIA output. If Txd is high, the output DIA transistor is OFF. If Txd is low the DIA output transistor is ON.

DIA (DIA)

Input / Output Diagnosis Bus line pin. This pin is an open collector structure, protected against over current and short circuit to VBAT (VS). When turning ON (TXD low), this pin will pull the Bus line to Gnd, the current into DIA will be internally limited to 60mA typ.

The internal power transistor has a thermal shutdown circuit, which forces the DIA output OFF in case of over temperature.

DIA is also the C1 comparator input. It is protected against both positive and negative over voltage by a 38V zener diode. This pin exhibits a constant input current of 7.5?A.

GND (GND)

Gnd reference for the entire device.

I1 (I1)

Bus source current pin. It is normally tied to DIA pin and to the Bus line.

At static HIGH or LOW level Txd, the current source I1 delivers a current of 3mA (typ). Only during LOW to HIGH transition, does this current increase to a higher value in order to charge the key line capacitor (Cl<4nF) in a short time (see fig 3 and 4).

L (L)

Input for C2 comparator. This pin is protected against both positive and negative over voltage by a 38V zener diode.

This L line is a second independent input. It can be used for wake up sequence in ISO diagnosis or as an additional input bus line.

This pin exhibits a constant input current of 7.5μA.

VS (VS)

12V typical, or Vbat supply pin for the device. This pin is protected against over voltage transients.

REF-OUT (REF-OUT)

Internal reference voltage generator output pin. Its value depends on Vs (Vbat) values. This output can be directly connected to REF-IN L and REF-IN-K, or through a resistor network. Maximum current capability is 50μA.

FUNCTIONAL DEVICE OPERATION

POWER SUPPLIES AND REFERENCE VOLTAGE

The device has two power supplies :

A 5V supply, VCC, normally connected to the MCU supply voltage. This pin sinks typically 1mA during operation. A VBAT supply voltage, VS, normally tied to the car battery voltage. This pin can sustain up to 40V DC. Care should be taken for reverse battery protection and transient voltages higher than 40V.

The voltage reference generator is supplied from both VCC and VBAT. It provides reference voltage for the K and L lines comparators thresholds. The reference voltage is dependant on VBAT voltage : it is linear versus VBAT voltage, for VBAT from 5.6V to 18V. Below 5.6V and over 18V the reference voltage is clamped (see Figure 12). The reference is connected externally to the device, through REF-OUT pin. It is available for other needs. It can supplied 50μA max (see Figure 13).

PATH FUNCTIONS BETWEEN MCU, K AND L LINES

The path function from the MCU to the K line is composed of a driver interfacing directly with the MCU through the TXD pin. The TXD pin is CMOS compatible. This driver controls a power transistor which can be turned ON or OFF. When it is ON, it pull the DIA pin low. This pin is known as K line in the ISO 9141 specification. The DIA pin structure is open collector, without pull up component. This allow the connection of several MC33199 on the K line and the use of a single pull up resistor per system (see Figure 25). In order to protect the DIA pin against short circuits to VBAT, the device incorporates a current limitation (see Figure 17) and a thermal shutdown. This current limitation will also act when the device drives a K line bus exhibiting large parasitic capacitor value (see Special functionality of I1 pin).

The path from this DIA pin, or K line, to the MCU is done through a comparator. The comparator threshold voltage is connected to REF-IN-K pin. It can be tied to the REF-OUT voltage, if the VBAT dependant threshold is to be achieved. The second input of this comparator is internally connected to DIA pin. The output of the comparator is available on RXD output pin, normally connected to a MCU I/O port. RXD pin has a 2kOhms internal pull up resistor.

The path from the L line, used during wake-up sequence of the transmission, to the MCU is done through a second comparator. The comparator threshold voltage is connected to REF-IN-L pin. As the REF-IN-K pin, it can be tied to the REFOUT voltage, if the VBAT dependant threshold need to be achieved. The second input of this comparator is internally connected to L pin. The output of the comparator is available on LO output pin, which is an open collector structure. LO is normally connected to a MCU I/O port.

The DIA, and L pins can sustain up to 38V DC. Care should be taken for reverse battery protection and transient voltages higher than 38V.

The DIA and L pins both have internal pull down current source of typically 7.5μA (see Figure 15). So the L line exhibits a 10μA pull down current. The DIA pin has the same behavior when it is in OFF state, that is when TXD is at logic high level.

SPECIAL FUNCTIONALITY OF I1 PIN

The MC33199 has a unique feature which allows the transmission Baud rate to be up to 200kBaud. In practice, the K line can be several meters long, and thus can have a large parasitic capacitor value. This parasitic capacitor value will slow down the low to high transition of the K line, and indeed will limit the Baud rate transmission. For the K line to go from low to high level, the parasitic capacitor need to be charged, and it can only be charged by the pull up resistor. A low pull up resistor value would result in fast charge time of the capacitor, but also in large output current, and large power dissipation in the driver.

To avoid this problem, the MC33199 incorporates a dynamic current source, which is temporary activated at the low to high transition of the TXD pin, that is when the DIA pin or K line should switch from low to high level (see Figure 6 & Figure 7).

This current source is available at I1 pin. It has a typical value of 80mA. It is activated for 4μs (see Figure 22 & Figure 23) and is automatically disabled after this time. During that time it will charge the K line parasitic capacitor. This extra current will quickly rise the K line voltage up to the Vbat, and will result in reduce rise time on the K line. With this feature the MC33199 can ensure Baud rate transmission of up to 200kBaud.

During high to low transition on the K line, the parasitic capacitor of the bus line will be discharged by the output transistor of the DIA pin. In this case, the total current may exceed the internal current limitation of the DIA pin. If so, the current limitation will act, and discharge current will be limited to typically 60mA (See Figure 7 & Figure 17).

If a high Baud rate is necessary, the I1 pin need to be connected to the DIA as shown in the typical application Figure 24. The I1 pin can also be left open, if the I1 functionality and high Baud rate are not suited in the application.

TYPICAL APPLICATIONS

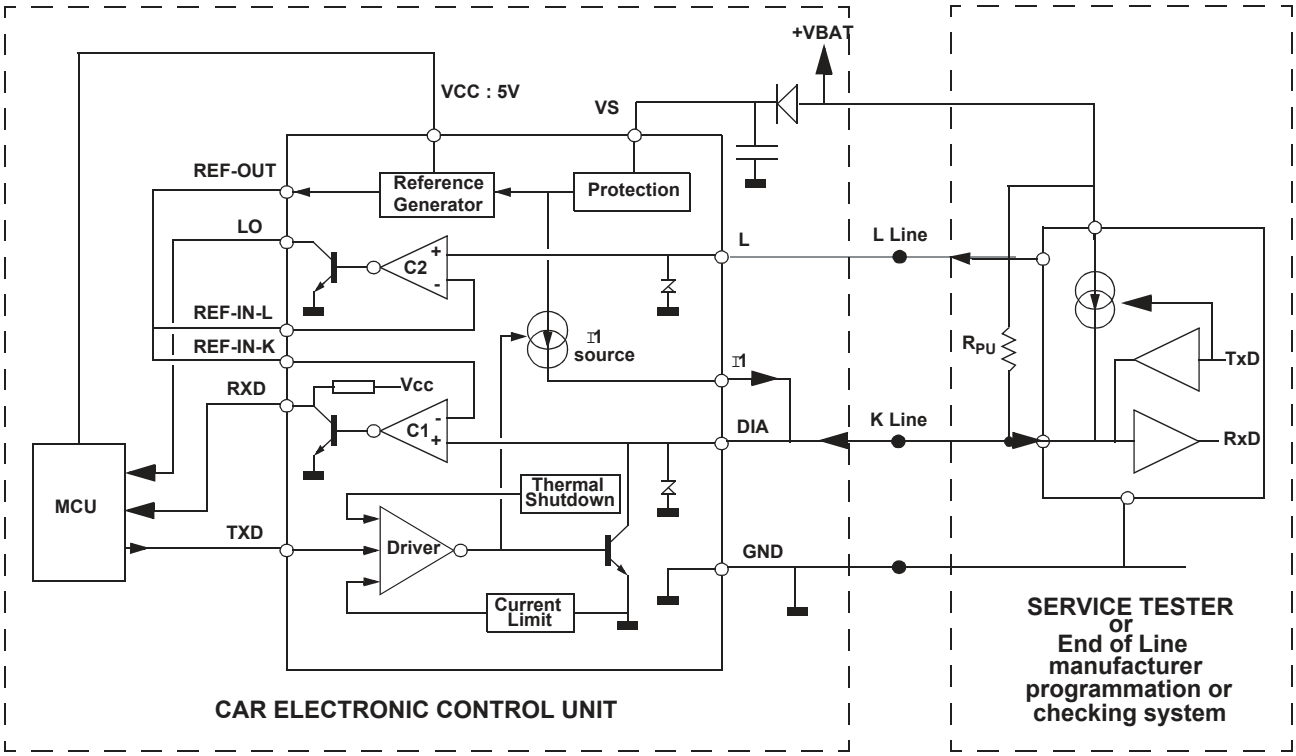


Figure 24. Logic Diagram and Application Schematic

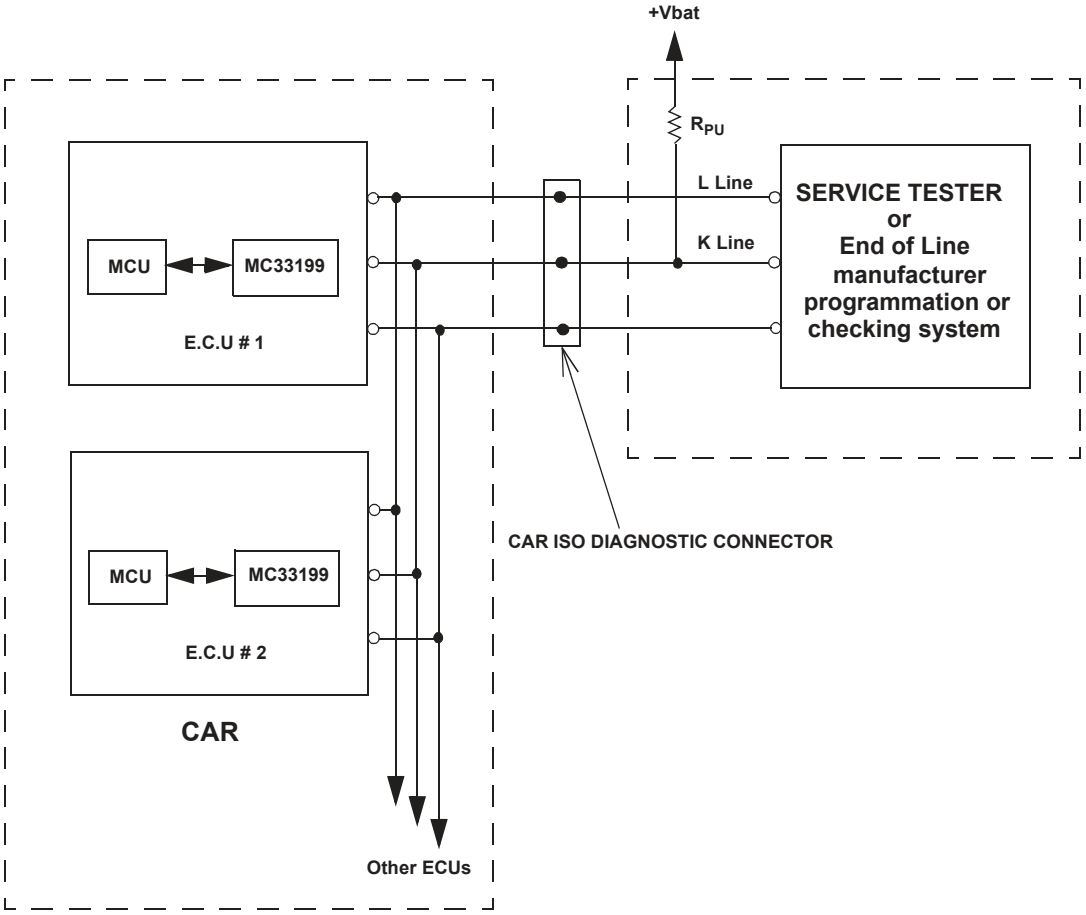


Figure 25. Typical Application with Several ECUs

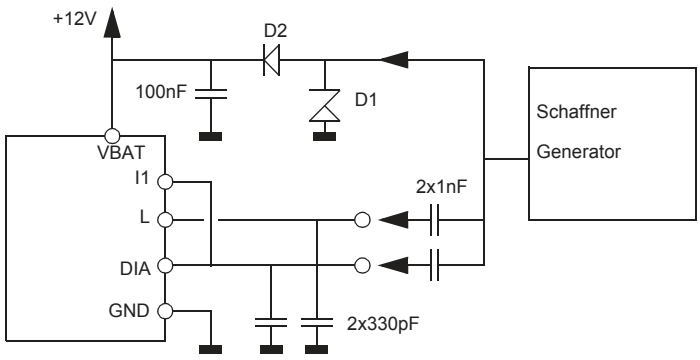


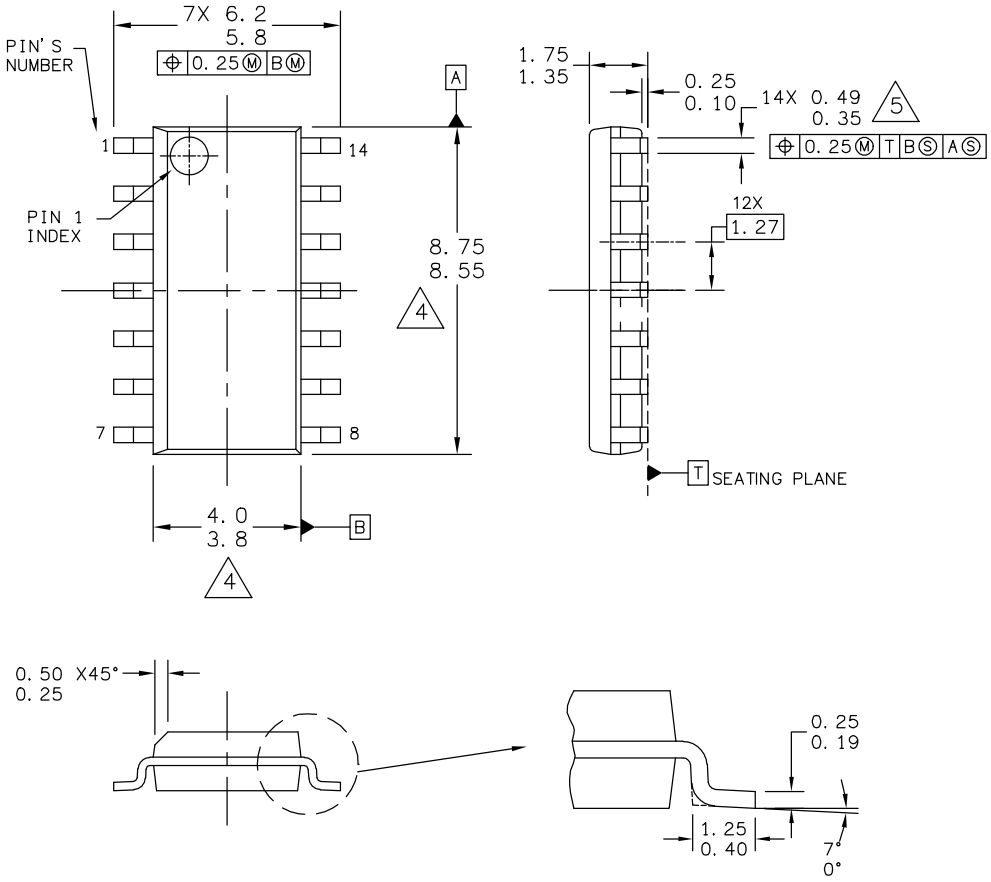
Figure 26. Test Circuit for Transient Schaffner Pulses

Test pulses are directly applied to VS and via a capacitor of 1nF to DIA and L. The voltage VS is limited to -2V/38V by the transient suppressor diode D1. Pulses can occor simultaneously or separately.

PACKAGING

PACKAGE DIMENSIONS

For the most current package revision, visit **www.freescale.com** and perform a keyword search using the “98A” listed below.



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ISSUE H

ARCHIVE INFORMATION

REVISION HISTORY

Revision	Date	Description of Changes
2.0	8/2006	• Implemented Revision History page • Added EF Pb-FREE suffix • Revised Figure 1, Simplified Application Drawing. • Converted to Freescale format and updated to the prevailing form and style • Removed MC33199EF/R2 and replaced with MCZ33199EF/R2 in the Ordering Information block
	9/2006	• Made unit label corrections on Transmission Speed, High or Low Bit Time, LO Output :, and I1 Output @ VS-I1 > 2.7V : on page 7.
	10/2006	• Removed Peak Package Reflow Temperature During Reflow (solder reflow) parameter from Maximum Ratings on page 4. Added note with instructions to obtain this information from www.freescale.com.

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