MOTOROLA
SEMICONDUCTOR

MC33199

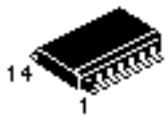
Automotive ISO 9141 Serial Link Driver

The MC33199D 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 MC33199D 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 MC33199D has a unique feature which allow transmission Baud rate up to 200kBauds.

- Electrically Compatible with Specification “Diagnosis System ISO9141”
- Transmission speed up to 200kBauds
- Internal Voltage Reference Genarator 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

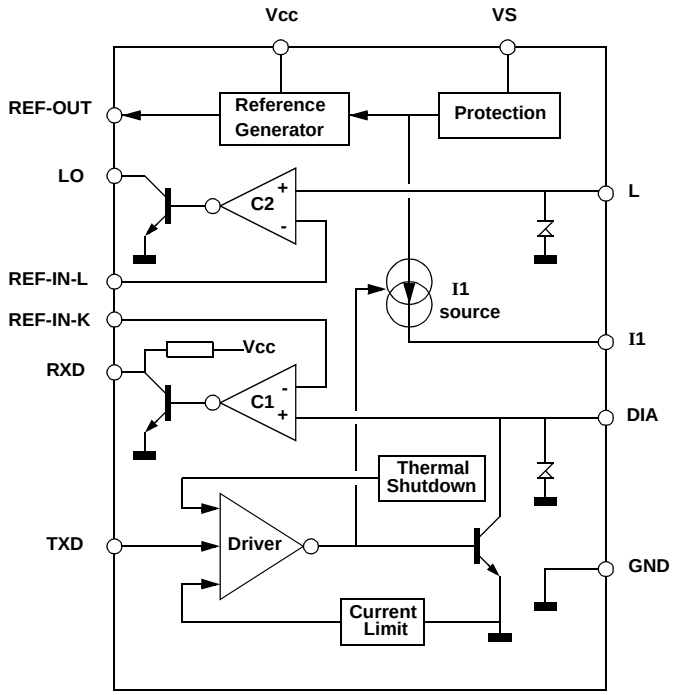
ISO 9141 SERIAL LINK DRIVER

SEMICONDUCTOR
TECHNICAL DATA

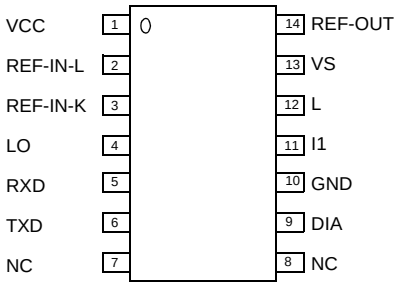


D SUFFIX
PLASTIC PACKAGE
CASE 751A-02
SO-14

Block Diagram and Typical Application



PIN CONNECTIONS



ORDERING INFORMATION		
Device	**Temperature Range**	**Package**
MC33199D	- 40°C to+125°C	SO14

MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
ELECTRICAL RATINGS (Note 1)			
Vs Supply Pin: - DC Voltage Range - Transient Pulse (Note 2)	 Vs Vpulse	 - 0.5 to + 40 - 2 to + 40	V
Vcc Supply DC Voltage Range	Vcc	- 0.3 to + 6	V
DIA and L Pins (Note 2) : - DC Voltage Range - Transient Pulse (clamped by internal diode) - DC Source Current - DIA Low Level Sink Current		 - 0.5 to + 38 - 2 - 50 Int. Limit	 V V mA mA
TXD DC Voltage Range		-0.3 to Vcc +0.3	V
REF-IN DC Voltage Range - VS < Vcc - VS > Vcc		 -0.3 to Vcc -0.3 to VS	V
ESD Voltage Capability	V(ESD)	+/-2000	V
THERMAL RATINGS			
Storage Temperature	Tstg	- 55 to + 150	°C
Operating Junction Temperature	Tj	- 40 to + 150	°C
Thermal Resistance, Junction to air	Rtja	180	°C/W
Max Power Dissipation (@ Tamb=105°C)	Pd	250	mW

NOTE 1 : The device is compatible with Specification: “Diagnosis System ISO9141”

NOTE 2 : See the test Circuit (Fig.23). Transient test pulse according to ISO76371 and DIN 40839, highest test levels.

ELECTRICAL CHARACTERISTICS. Tamb from - 40°C to + 125°C, Vcc from 4.5V to 5.5V, Vs 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.

Parameters	Symbol	Min	Typ	Max	Unit
VCC Pin 1					
Vcc Supply Voltage Range	Vcc	4.5		5.5	V
Vcc Supply Current (Note 3)	Icc	0.5	1	1.5	mA
REF-IN-L Pin 2 and REF-IN-K pin 3					
REF-IN-L & REF-IN-K Input Voltage Range: - for 0 <Vs< Vcc - for Vcc <Vs< 40V	Vinref	 2 2		 Vcc - 2V Vs - 1V	V
REF-IN-L & REF-IN-K Inputs Currents	Ivin	- 5		5	µA
LO Pin 4					
LO open Collector Output - Low Level Voltage @ Iout = 1mA - Low Level Voltage @ Iout = 4mA	Vol		 0.34	 0.7 0.8	V
RXD Pin 5					
Pull up resistor to Vcc	Rrxd	1.5	2	2.5	kΩ
Low Level Voltage @ Iout=1mA	Vol		0.3	0.7	V
TXD Pin 6					
High Level Input Voltage	Vih	0.7Vcc	2.8		V
Low Level Input Voltage	Vil		2	0.3Vcc	V

ELECTRICAL CHARACTERISTICS. Tamb from - 40°C to + 125°C, Vcc from 4.5V to 5.5V, Vs 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.

Parameters	Symbol	Min	Typ	Max	Unit
Input Current @ 0<Vs<40V - TXD at High Level - TXD at Low Level	 Ih Il	 - 200 - 600		 + 30 - 100	µA
DIA INPUT / OUTPUT Pin 9					
Low Level Output Voltage @ I = 30mA	Vol	0	0.35	0.8	V
Drive Current Limit	Ilim	40		120	mA
High Level Input Threshold Voltage (REF-IN-K connected to REF-OUT)	Vih	Vref min + 0.25V	Vref + 0.325V	Vref max + 0.4V	V
Low Level Input Threshold Voltage (REF-IN-K connected to REF-OUT)	Vil	Vref min - 0.2V	Vref - 0.125V	Vref max - 0.05V	V
Input Hysteresis	Vhyst	300	450	600	mV
Leakage Current (Note 4)	Ileak	4	10	16	uA
Over temperature Shutdown (Note 5)	Tlim	155			°C
L INPUT Pin 12					
High Level Input Threshold Voltage (REF-IN-L connected to REF-OUT)	Vih	Vref min + 0.25V	Vref + 0.325V	Vref max + 0.4V	V
Low Level Input Threshold Voltage (REF-IN-L connected to REF-OUT)	Vil	Vref min - 0.2V	Vref - 0.125V	Vref max - 0.05V	V
Input Hysteresis	Vhyst	300	450	600	mV
Leakage Current (Note 6)	Ileak	4	10	16	uA
L1 INPUT Pin 11					
Static Source Current	I1s	- 4	- 3	- 2	mA
Static Saturation Voltage @ I1s=-2mA	VI1sat	Vs - 1.2	Vs - 0.8	Vs	V
Dynamic Source Current (Note 8)	I1d	- 120	- 80	- 40	mA
Dynamic Saturation Voltage @ I1s=-40mA	VI1dsat	Vs - 2.7	Vs - 0.85	Vs	V
VS Pin 13					
Vs Supply Voltage Range	Vs	4.5		20	V
Vs Supply Current (Note 8)	Is	0.5	1.3	2	mA
REF-OUT Pin 14					
Output Voltage : @ 3 < Vs < 5.6V & Iro = +-10µA @ 5.6 < Vs < 18V & Iro = +-10µA @ 18 < Vs < 40V & Iro = +-10µA	Vref	 2.7 0.5 x Vs 8.5		 3.3 0.56 xVs 10.8	V
Maximum output current	Iout	- 50		50	µA
Pull-up resistor to Vcc	Rpu	3	8	12	KΩ

NOTE 3: Measured with TXD=Vcc, I1=Vs, DIA & L high, no load, REF-IN-L and REF-IN-K connected to REF-OUT.

DYNAMIC CHARACTERISTICS. Tamb from - 40°C to + 125°C, Vcc from 4.5V to 5.5V, Vs from 4.5V to 20V unless otherwise note

Parameters	Symbol	Min	Typ	Max	Unit
Transmission Speed	1/t Bit	0		200K	Bd
High or Low Bit Time	t Bit	5			µs

DYNAMIC CHARACTERISTICS. Tamb from - 40°C to + 125°C, Vcc from 4.5V to 5.5V, Vs from 4.5V to 20V unless otherwise note

Parameters	Symbol	Min	Typ	Max	Unit
Rxd Output : - Low to High Transition Delay Time - High to Low Transition Delay Time	 tRdr tRdf			 450 450	ns
LO Output : - Low to High Transition Delay Time - High to Low Transition Delay Time	 tLdr tLdf			 2 2	µs
DIA Output : - Low to High Transition Delay Time - High to Low Transition Delay Time	 tDdr tDdf			 650 650	ns
I1 Output @ Vs-I1 > 2.7V : - Rise time - Hold Time	 tI1r tI1f	 1.5		 0.3 4.5	µs
Parameters	**Symbol**	**Min**	**Typ**	**Max**	**Unit**

Figure 1. TXD to DIA AC Characteristic

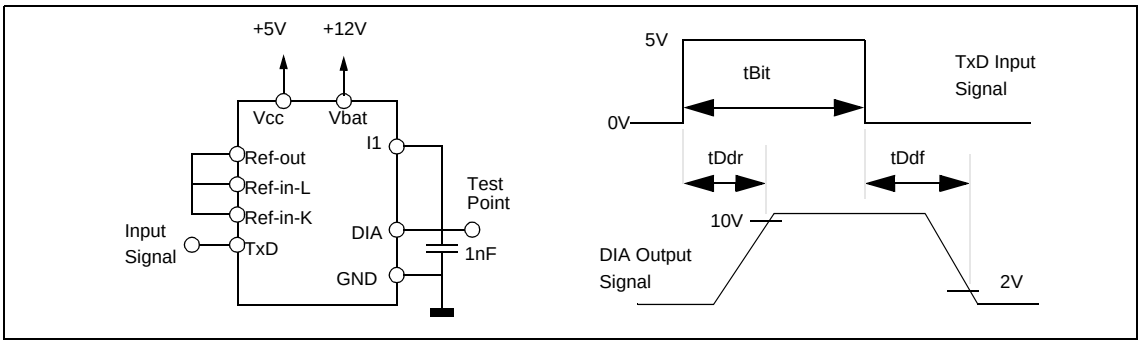


Figure 2. DIA to TxD and L to LO AC Characteristics

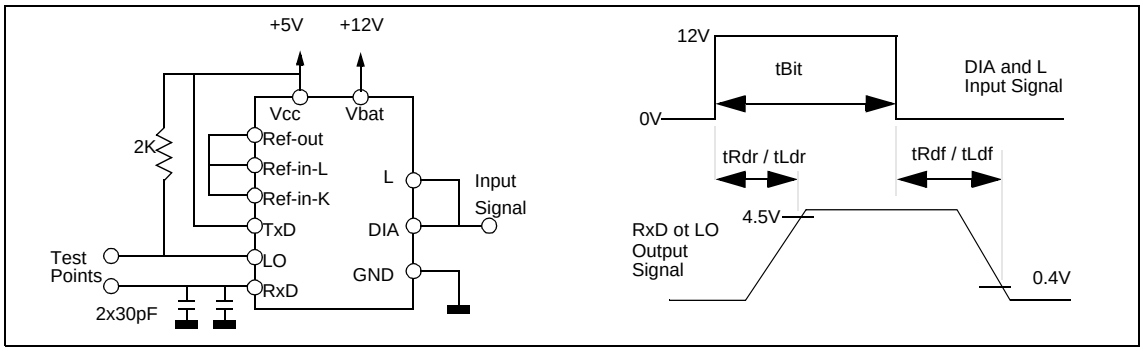
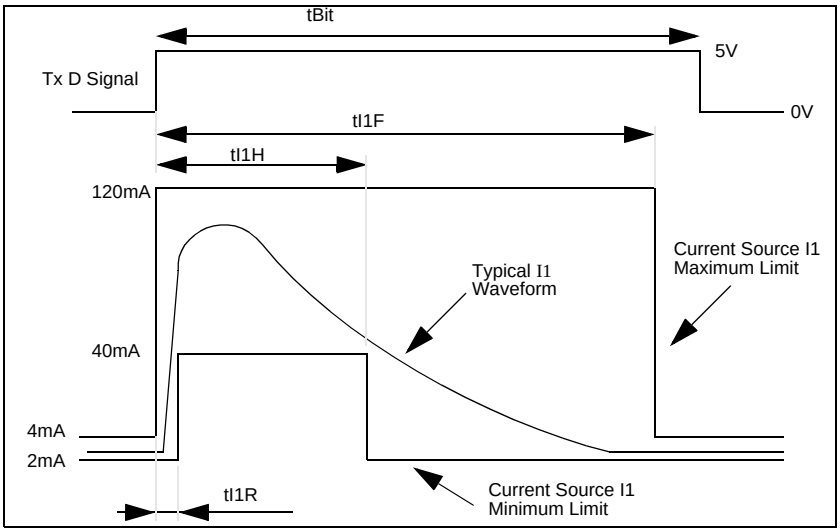


Figure 3. Current Source I1 AC Characteristics



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.

Figure 4. Current Source I1 and DIA Discharge current test schematic.

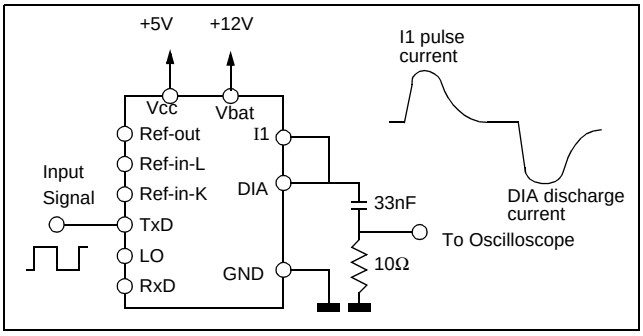


Figure 5. Logic diagram and application schematic

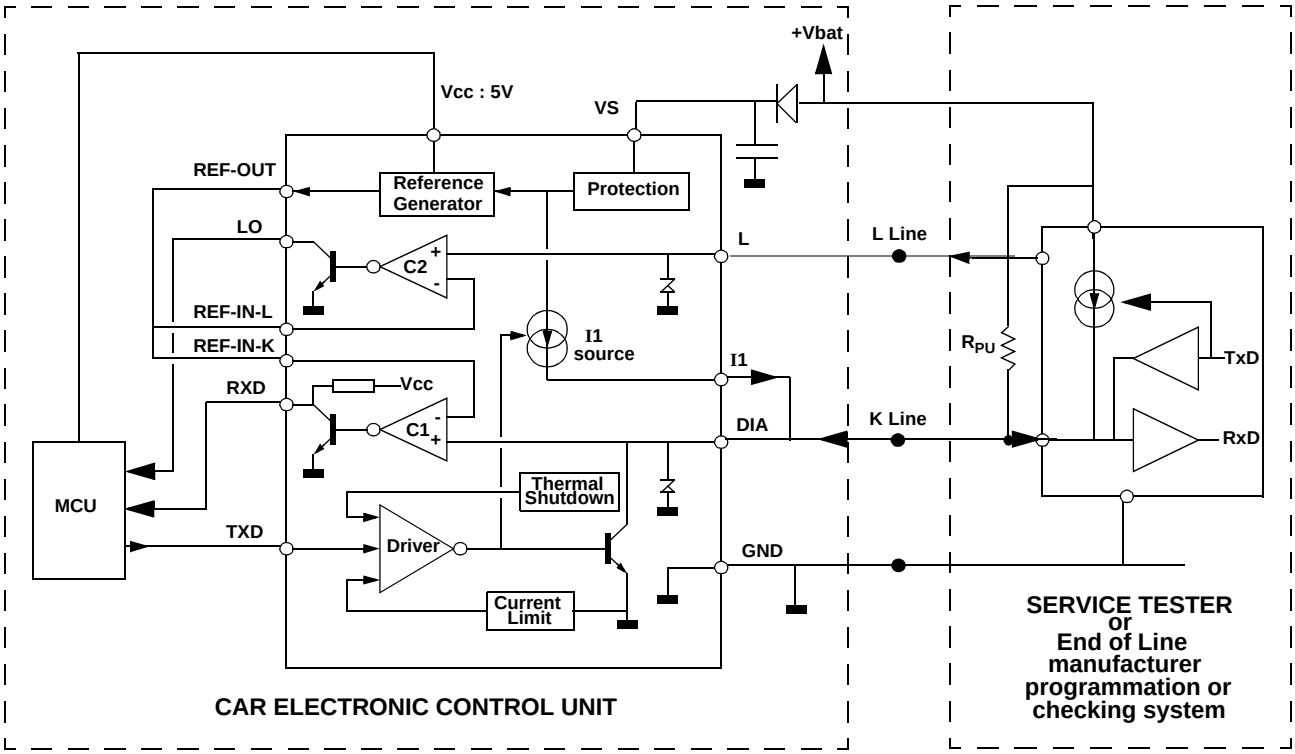


Figure 6. : Typical application with several ECUs

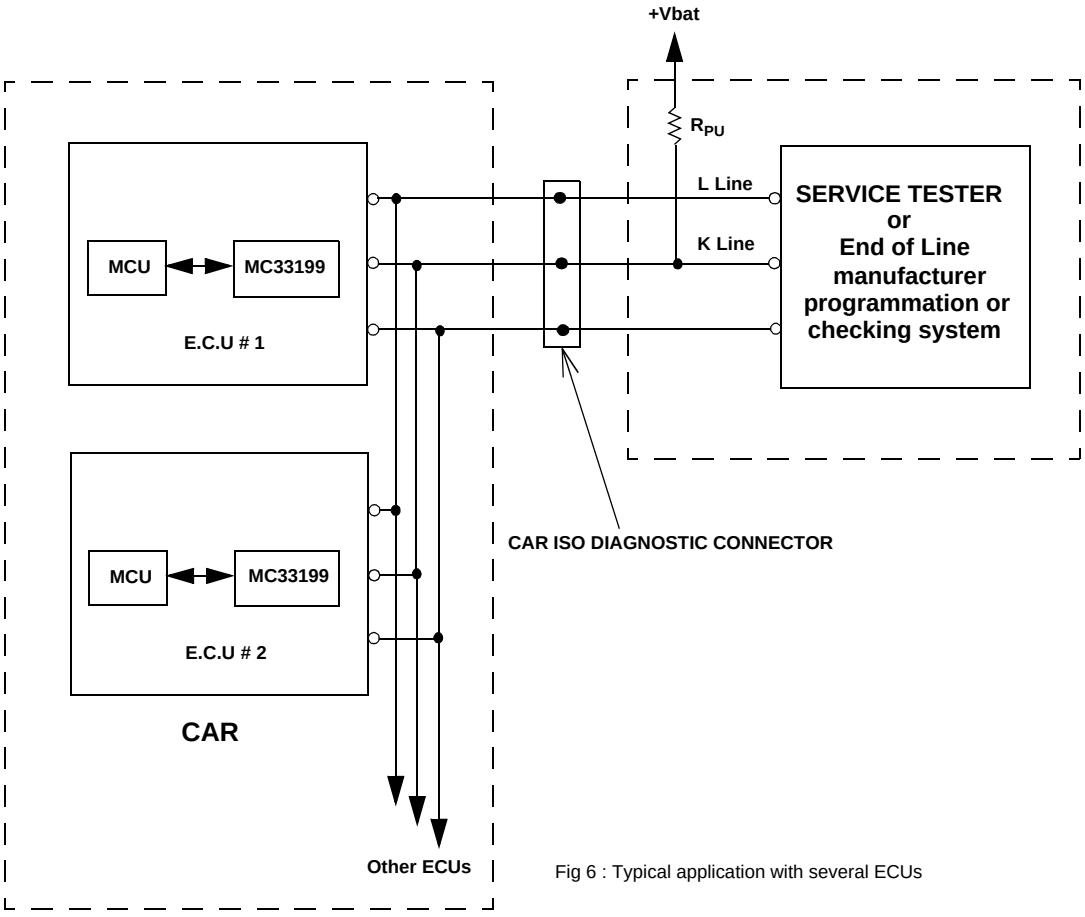


Fig 6 : Typical application with several ECUs

Figure 7. Icc supply current versus temperature

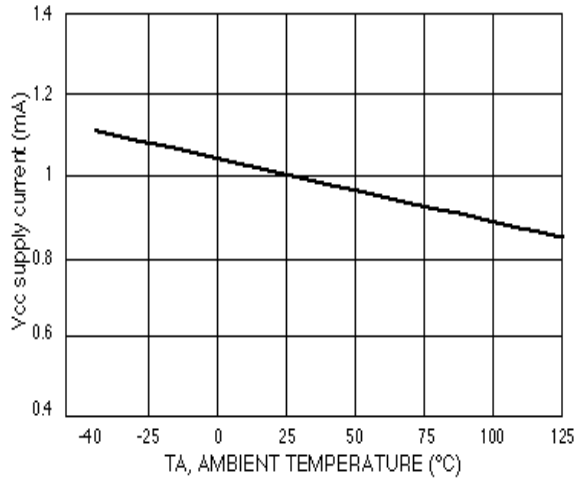


Figure 8. S supply current versus VS supply voltage

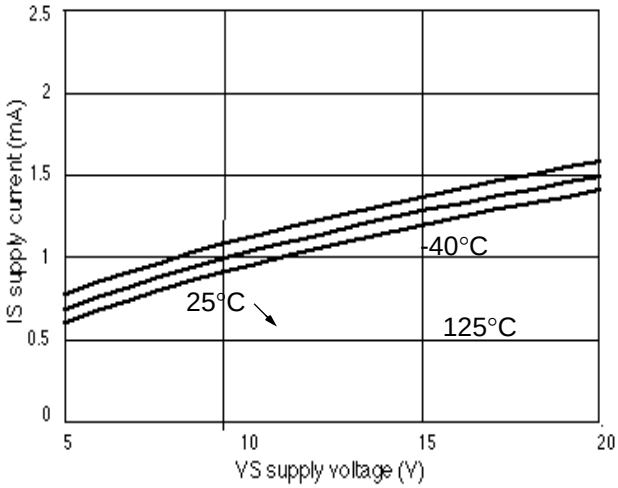


Figure 9. IS supply voltage versus VS Supply voltage

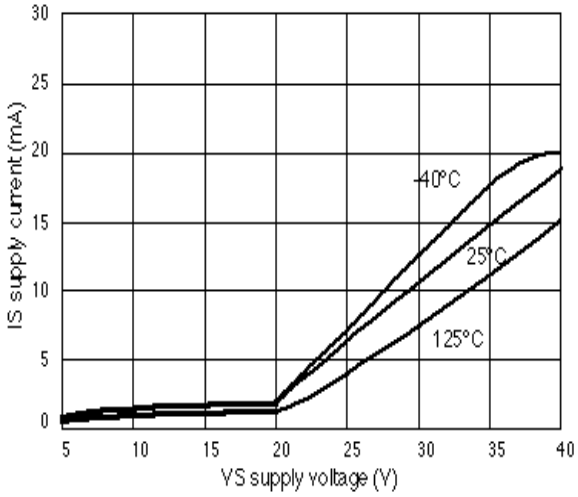


Figure 10. VS voltage versus IS current (Vcc=5.5V,Vdia,L,I1=20V)

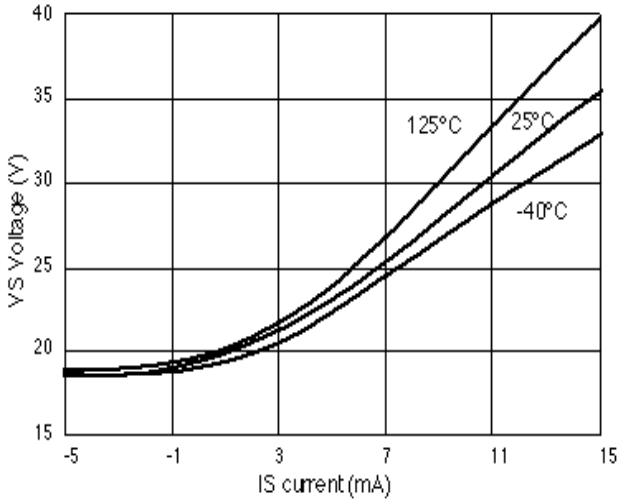


Figure 11. REF-OUT Voltage versus VS Supply voltage

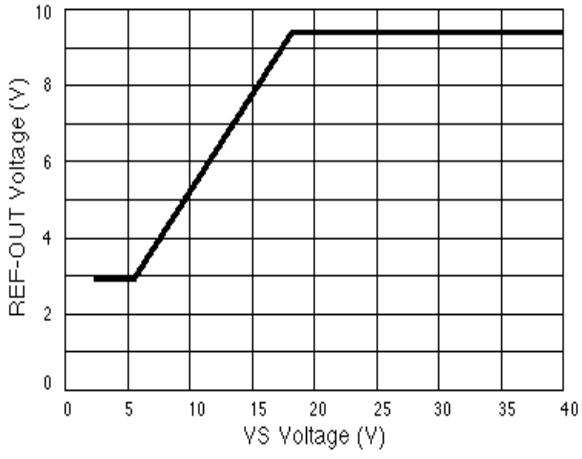


Figure 12. REF-OUT Voltage versus REF-OUT current

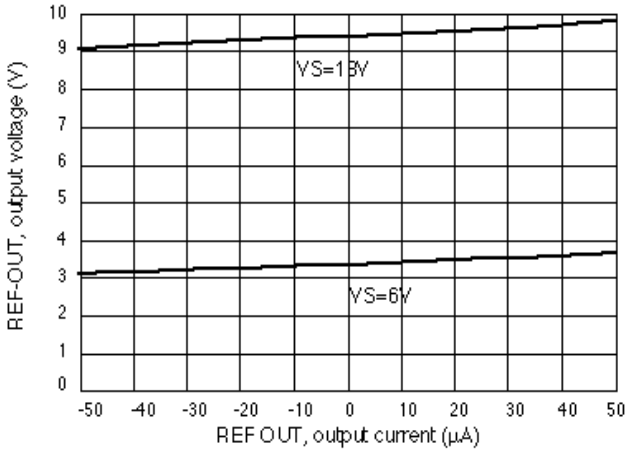


Figure 13. L and DIA hysteresis versus temperature

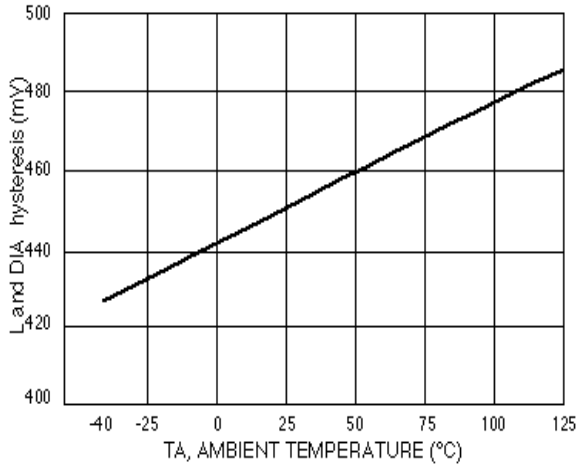


Figure 14. L and DIA current versus L and DIA voltage

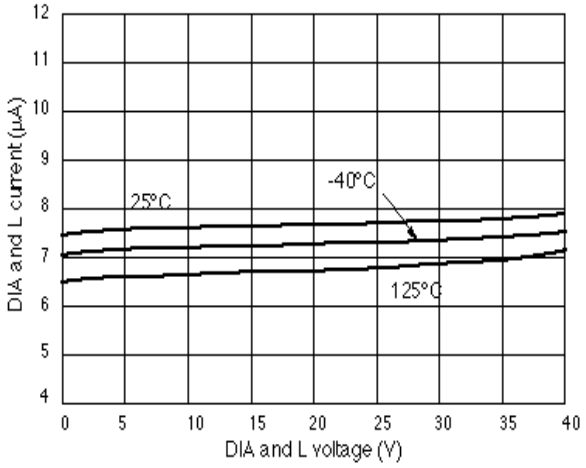


Figure 15. DIA saturation voltage versus temperature

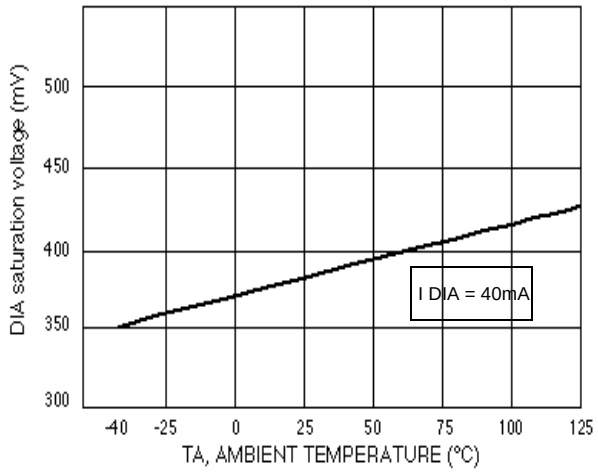


Figure 16. DIA current limit versus temperature

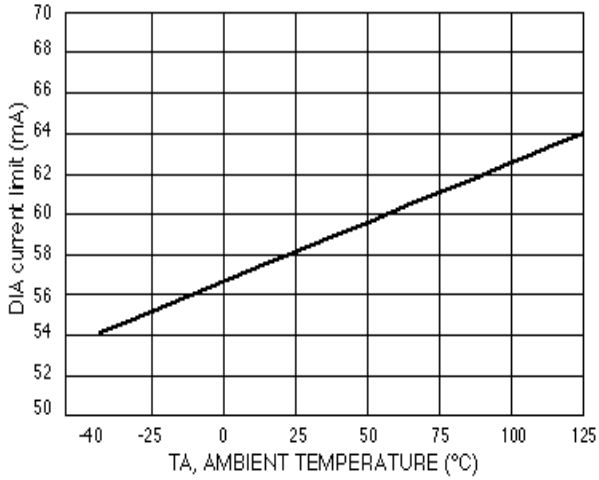


Figure 17. RXD pull-up resistor versus temperature

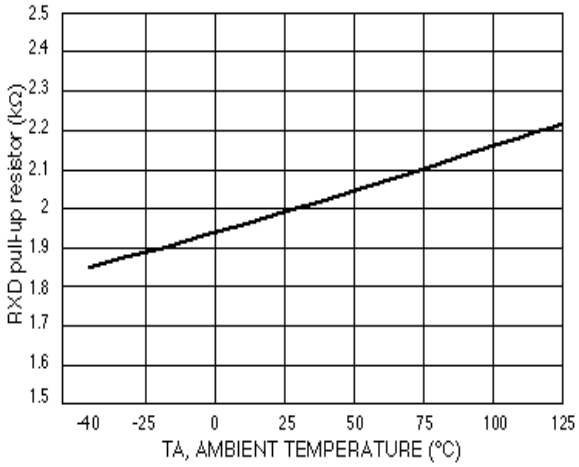


Figure 18. TXD and LO saturation voltage versus temperature

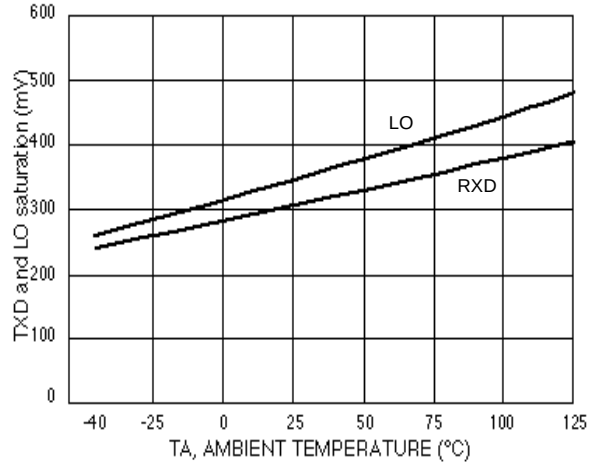


Figure 19. I1 saturation voltage versus temperature

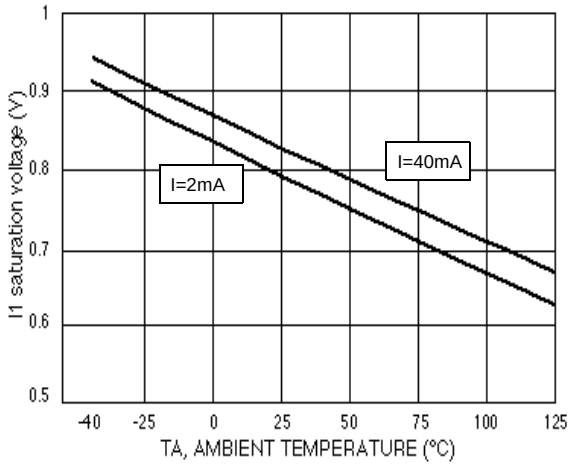


Figure 20. I1 Output DC Current versus temperature

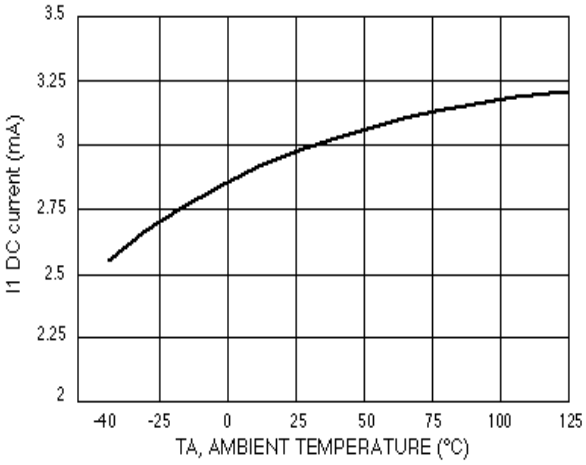


Figure 21. I1 Output Pulse Current versus VS Supply Voltage

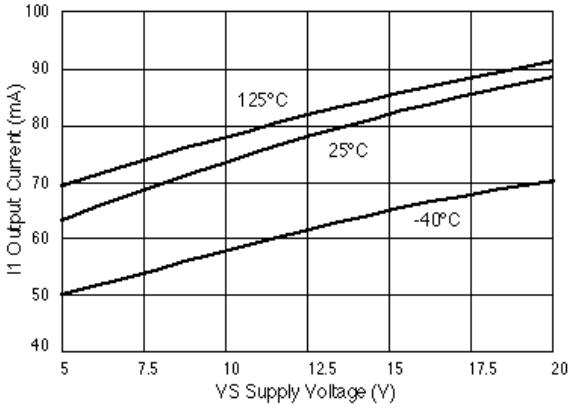


Figure 22. I1 Pulse current width versus temperature

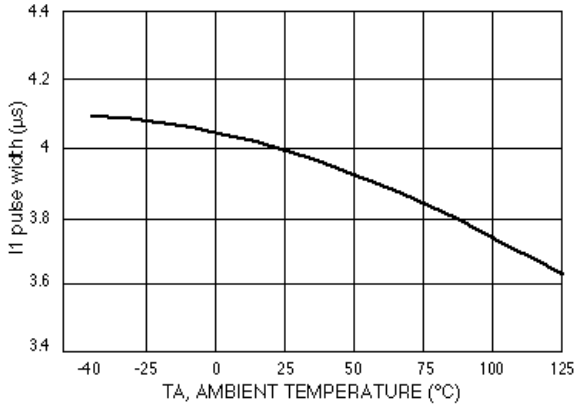
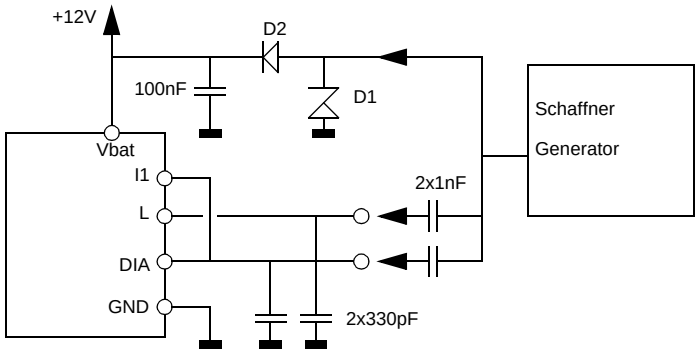


Figure 23. Test circuit for transient Schaffner pulses



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 occur simultaneously or separately.

DEVICE DESCRIPTION

Introduction

The MC33199D 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 MC33199D has been designed to meet the «Diagnosis System ISO9141» specification.

This product description will detail the functionality of the device (see simplified 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.

Power supplies and reference voltage

The device has two power supplies :

A 5V supply, Vcc, normally connected to the MCU supply voltage. This pin sink 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 fig 11). The reference is connected externally to the device, through REF-OUT pin. It is available for other needs. It can supplied 50uA max (see fig 12).

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 fig 6). In order to protect the DIA pin against short circuits to Vbat, the device incorporates a current limitation (see fig 16) 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* below).

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 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 REF-OUT 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 7,5uA (see fig 14). So the L line exhibits a 10uA pull down current. The DIA pin has the same behaviour when it is in OFF state, that is when TXD is at logic high level.

Special functionality of I1 pin

The MC33199D has a unique feature which allow the transmission Baud rate to be up to 200kBauds. 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 MC33199D 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 fig 3 & 4).

This current source is available at I1 pin. It has a typical value of 80mA. It is activated for 4us (see fig 21 & 22) 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 MC33199D can ensure Baud rate transmission of up to 200kBauds.

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 fig 4 & 16).

If a high Baud rate is necessary, the I1 pin need to be connected to the DIA as shown in the typical application fig 5. The I1 pin can also be left open, if the I1 functionality and high Baud rate are not suited in the application.

PIN FUNCTION DESCRIPTION

Pin 1 : Vcc

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

Pin 2 : 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.

Pin 3 : 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.

Pin 4 : LO

Output of C2 comparator, normally connected to a microcontroller 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.

Pin 5 : 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 (2KΩ typ). Drive capability of this output is 5mA

Pin 6 : TXD

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

Pin 9 : 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 7,5µA.

Pin 10 : GND

Gnd reference for the entire device.

Pin 11 : 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).

Pin 12 : 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.

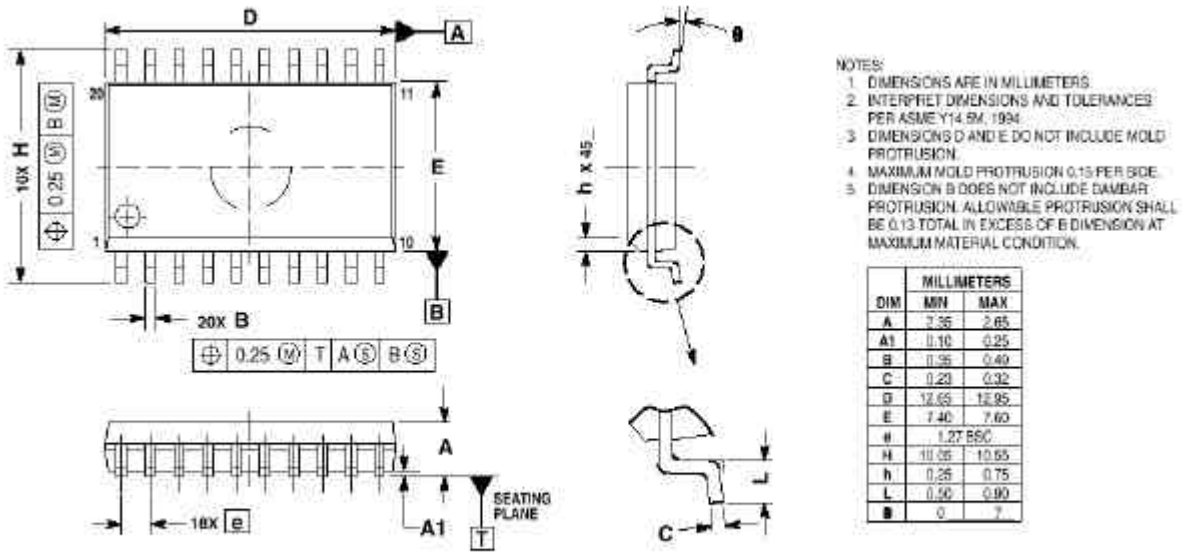
This pin exhibits a constant input current of 7.5µA.

Pin 13 : VS

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

Pin 14 : 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.



NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF B DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS	
DIM	MIN	MAX
A	2.35	2.65
A1	0.10	0.25
B	0.35	0.49
C	0.23	0.32
D	12.65	12.95
E	7.40	7.60
e	1.27 BSC	
H	10.05	10.65
h	0.25	0.75
L	0.50	0.90
θ	0	7