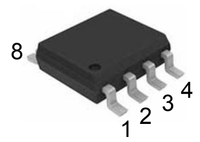
HIGH SPEED CAN TRANSCEIVER

DESCRIPTION

The ***STComponet*** STC1040 is the interface between the Controller Area Network (CAN) protocol controller and the physical bus. The STC1040 provides differential transmit capability to the bus and differential receive capability to the CAN controller. It is primarily intended for high speed applications, up to 1MBaud, in passenger cars.



SOP-8

The STC1040 is pin compatible with STC1050 high speed CAN transceiver and offers the excellent EMC performance. The features include an ideal passive behavior when supply voltage is off, and a very low-current standby mode with remote wake-up capability via the bus.

FEATURES

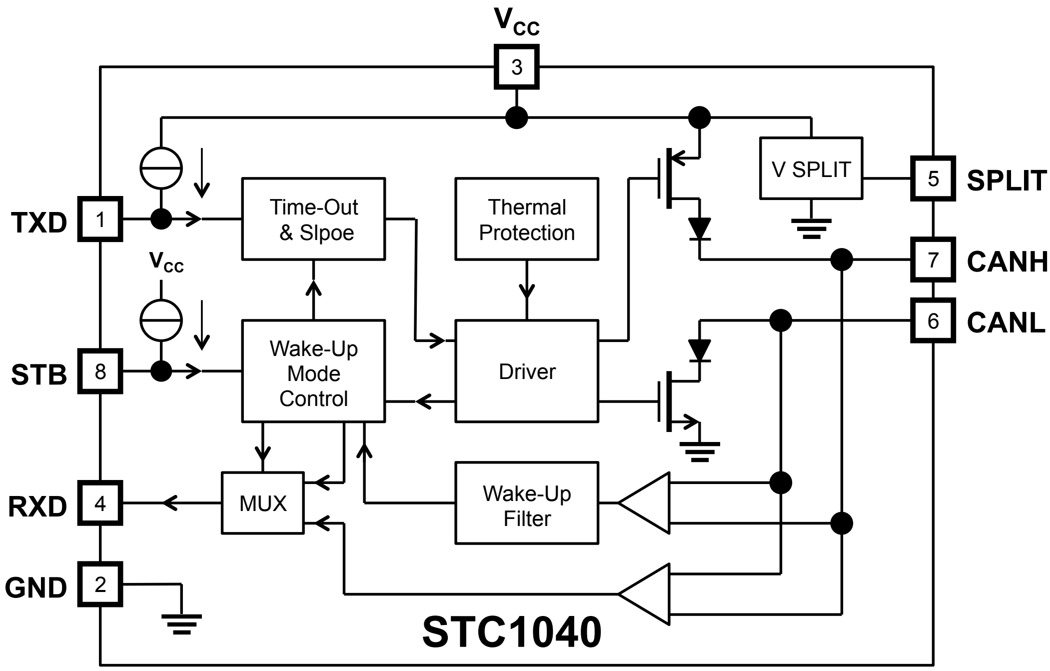
- Fully Compatible with ISO 11898 Standard
- High Speed (Up to 1MBaud)
- Very Low Electro-Magnetic Emission (EME)
- Differential Receiver with High Common-Mode Range for Electro-Magnetic Immunity (EMI)
- Transceiver in Unpowered State Disengages from the Bus (Zero Load)
- Input Levels Compatible with 3.3V and 5.0V Devices
- Voltage Source for Stabilizing the Recessive Bus Level If Split Termination is Used (Further Improvement of EME)
- At Least 110 Nodes can be Connected
- Transmit Data (TXD) Dominant Time-Out Function
- Bus Pins Protected Against Transients in Automotive Environments
- Bus Pins and Pin SPLIT Short-Circuit Proof to Battery and Ground
- Thermally Protected

DEVICE SUMMARY

Ordering Code	Package Material	Package Type	Shipping	Marking[1]
STC1040B	Lead Free	SOP-8	Taping reel	1040 STC YM
STC1040BG	Halogen Free			

Note 1: **Y**: Year code.
M: Month code.

INTERNAL SCHEMATIC DIAGRAM



PIN DESCRIPTION

PIN	SYMBOL	FUNCTION DESCRIPTION
1	TXD	Transmit data input.
2	GND	Ground.
3	V_{CC}	Supply voltage.
4	RXD	Receive data output; Reads out data from the bus lines.
5	SPLIT	Common-mode stabilization output.
6	CANL	Low-level CAN bus line.
7	CANH	High-level CAN bus line.
8	STB	Standby mode control input.

ABSOLUTE MAXIMUM RATINGS (2)

T_A = 25°C, unless otherwise specified.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Supply Voltage	V_{CC}	No time limit	-0.3	+6.0	V
		Operating range	4.75	5.25	V
TXD Pin DC Voltage	V_{TXD}		-0.3	V_{CC} + 0.3	V
RXD Pin DC Voltage	V_{RXD}		-0.3	V_{CC} + 0.3	V
STB Pin DC Voltage	V_{STB}		-0.3	V_{CC} + 0.3	V
CANH Pin DC Voltage	V_{CANH}	0V < V_{CC} < 5.25V, no time limit	-27	+40	V
CANL Pin DC Voltage	V_{CANH}	0V < V_{CC} < 5.25V, no time limit	-27	+40	V
SPLIT Pin DC Voltage	V_{SPLIT}	0V < V_{CC} < 5.25V, no time limit	-27	+40	V
CANH, CANL and SPLIT Pins Transient Voltage	V_{TRT}	According to ISO 7637	-200	+200	V
ESD Human Body Model	HBM	CANH, CANL & SPLIT pins (3)	-6000	+6000	V
		Other pins	-4000	+4000	V
Machine Model (4)	MM		-200	+200	V
Virtual Junction Temperature (5)	T_{VJ}		-40	+150	°C
Storage Temperature	T_{stg}		-55	+150	°C

Note 2: Absolute Maximum Ratings are stress ratings only and functional device operation is not implied. The device could be permanently damaged beyond absolute maximum ratings.
Note 3: Equivalent to discharging a 100pF capacitor via a 1.5kΩ series resistor.
Note 4: Equivalent to discharging a 200pF capacitor via a 0.75μH series inductor and a 10Ω series resistor.
Note 5: Junction temperature in accordance with IEC 60747-1. An alternative definition of T_{VJ} is: $T_{VJ} = T_{amb} + P \times R_{th(VJ-amb)}$, where $R_{th(VJ-amb)}$ is a fixed value to be used for the calculating of T_{VJ}. The rating for T_{VJ} limits the allowable combinations of power dissipation (P) and ambient temperature (T_{amb}).

ELECTRICAL CHARACTERISTICS [6]

V_{CC} = 4.75V ~ 5.25V, T_{VJ} = -40°C ~ +150°C, and R_L = 60Ω unless otherwise noted. All voltages are defined with respect to GND; positive currents flow into the IC.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{CC} Supply Pin						
Supply Current — Standby mode	I_{CC}		5	10	15	μA
Supply Current — Normal mode		Recessive; V_{TXD} = V_{CC}	2.5	5	10	mA
		Dominant; V_{TXD} = 0V	30	50	70	mA
Transmit Data Input (TXD) Pin						
High Level Input Voltage	V_{IH}		2		V_{CC}+0.3	V
Low Level Input Voltage	V_{IL}		-0.3		+0.8	V
High Level Input Current	I_{IH}	V_{TXD} = V_{CC}	-5	0	+5	μA
Low Level Input Current	I_{IL}	Normal mode, V_{TXD} = 0V	-100	-200	-300	μA
Input Capacitance	C_i	Not tested		5	10	pF
Standby Mode Control Input (STB) Pin						
High Level Input Voltage	V_{IH}		2		V_{CC}+0.3	V
Low Level Input Voltage	V_{IL}		-0.3		+0.8	V
High Level Input Current	I_{IH}	V_{STB} = V_{CC}		0		μA
Low Level Input Current	I_{IL}	V_{STB} = 0V	-1	-4	-10	μA
Receive Data Output (RXD) Pin						
High Level Output Voltage	V_{OH}	Standby mode, I_{RXD} = -100μA	V_{CC}-1.1	V_{CC}-0.7	V_{CC}-0.4	V
High Level Output Current	I_{OH}	Normal mode, V_{RXD} = V_{CC} - 0.4V	-0.1	-0.4	-1	mA
Low Level Output Current	I_{OL}	V_{RXD} = 0.4V	2	6	20	mA
Common-Mode Stabilization Output (SPLIT) Pin						
Output Voltage	V_O	Normal mode, -500μA < I_O < +500μA	0.3V_{CC}	0.5V_{CC}	0.7V_{CC}	V
Leakage Current	$\lvert I_L \rvert$	Standby mode, -22V < V_{SPLIT} < +35V		0	5	μA
Bus Lines (CANH & CANL) Pins						
Dominant Output Voltage	$V_{O(dom)}$	V_{TXD} = 0V — CANH pin	3	3.6	4.25	V
		CANL pin	0.5	1.4	1.75	V
Matching of Dominant Output Voltage	$V_{O(dom)(m)}$	V_{CC} – V_{CANH} - V_{CANL}	-100	0	+150	mV

V_{CC} = 4.75V ~ 5.25V, T_{VJ} = -40°C ~ +150°C, and R_L = 60Ω unless otherwise noted. All voltages are defined with respect to GND; positive currents flow into the IC.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Bus Lines (CANH & CANL) Pins						
Differential Bus Output Voltage (V_{CANH} - V_{CANL})	$V_{O(dif)(bus)}$	V_{TXD} = 0V, dominant, 45Ω < R_L < 65Ω	1.5		3.0	V
		V_{TXD} = V_{CC}, recessive, no load	-50		+50	mV
Recessive Output Voltage	$V_{O(reces)}$	Normal mode, V_{TXD} = V_{CC}, no load	2	0.5V_{CC}	3	V
		Standby mode, no load	-0.1	0	+0.1	V
Short-Circuit Output Current	$I_{O(SC)}$	V_{TXD} = 0V				
		V_{CANH} = 0V, measure CANH	-40	-70	-95	mA
		V_{CANL} = 40V, measure CANL	40	70	100	mA
Recessive Output Current	$I_{O(reces)}$	-27V < V_{CAN} < +32V	-2.5		+2.5	mA
Differential Recessive Threshold Voltage	$V_{dif(th)}$	-12V < V_{CANL} & V_{CANH} < +12V				
		Normal mode (7)	0.5	0.7	0.9	V
		Standby mode	0.4	0.7	1.15	V
Differential Receiver Hysteresis Voltage	$V_{hys(dif)}$	-12V < V_{CANL} & V_{CANH} < +12V, normal mode	50	70	100	mV
Input Leakage Current	I_{LI}	V_{CC} = 0V, V_{CANH} = V_{CANL} = 5V	-5	0	+5	μA
Common-Mode Input Resistance	$R_{i(cm)}$	Standby or normal mode	15	25	35	kΩ
Common-Mode Input Resistance Matching	$R_{i(cm)(m)}$	V_{CANH} = V_{CANL}	-3	0	+3	%
Differential Input Resistance	$R_{i(dif)}$	Standby or normal mode	25	50	75	kΩ
Common-Mode Input Capacitance	$C_{i(cm)}$	V_{TXD} = V_{CC}, not tested			20	pF
Differential Input Capacitance	$C_{i(dif)}$	V_{TXD} = V_{CC}, not tested			10	pF
Timing Characteristics (8)						
Delay TXD to Bus Active	$t_{d(TXD-BUSon)}$	Normal mode	25	70	110	ns
Delay TXD to Bus Inactive	$t_{d(TXD-BUSoff)}$		10	50	95	ns
Delay Bus Active to RXD	$t_{d(BUSon-RXD)}$		15	65	115	ns
Delay Bus Inactive to RXD	$t_{d(BUSoff-RXD)}$		35	100	160	ns
Propagation Delay TXD to RXD	$t_{PD(TXD-RXD)}$	V_{STB} = 0V	40		255	ns
TXD Dominant Time-Out	$t_{dom(TXD)}$	V_{TXD} = 0V	300	600	1000	μs

V_{CC} = 4.75V ~ 5.25V, T_{VJ} = -40°C ~ +150°C, and R_L = 60Ω unless otherwise noted. All voltages are defined with respect to GND; positive currents flow into the IC.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Timing Characteristics (8)						
Dominant Time for Wake-Up via Bus	t_{BUS}	Standby mode	0.75	1.75	5	μs
Delay Standby Mode to Normal Mode	$t_{d(stb-norm)}$	Normal mode	5	7.5	10	μs
Thermal Shutdown						
Shutdown Junction Temperature	$T_{J(sd)}$		155	165	180	°C

Note 6: All parameters are guaranteed in the virtual junction temperature range by design, but only 100% tested at 25°C ambient temperature for final tested.
Note 7: See the *Figure 2*.
Note 8: See the *Figure 3* and *Figure 4*.

TEST INFORMATION AND CIRCUIT

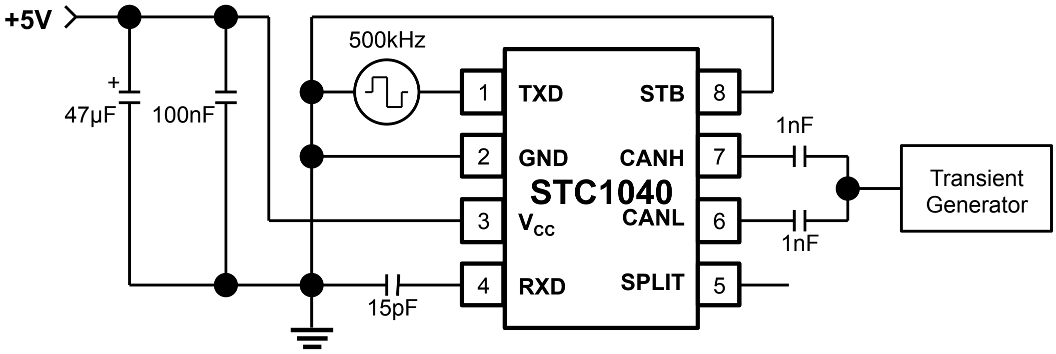


Figure 1: Automotive Transients Test Circuit

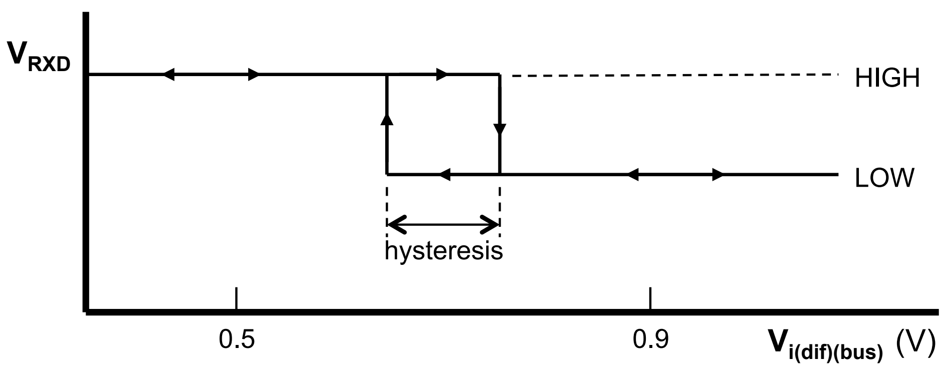


Figure 2: Hysteresis of the Receiver

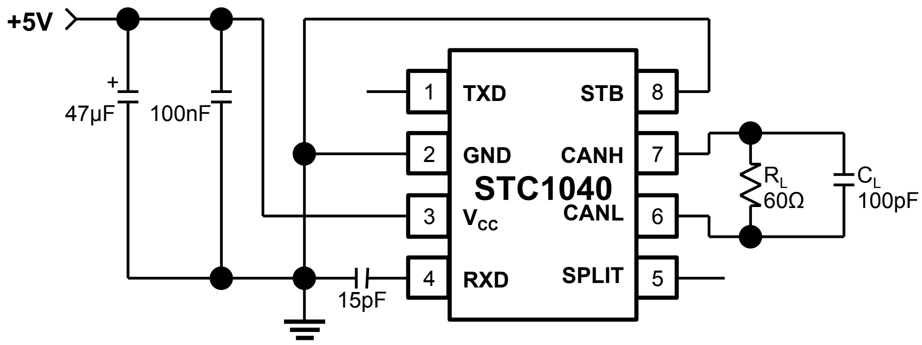


Figure 3: Test Circuit for Timing Characteristics

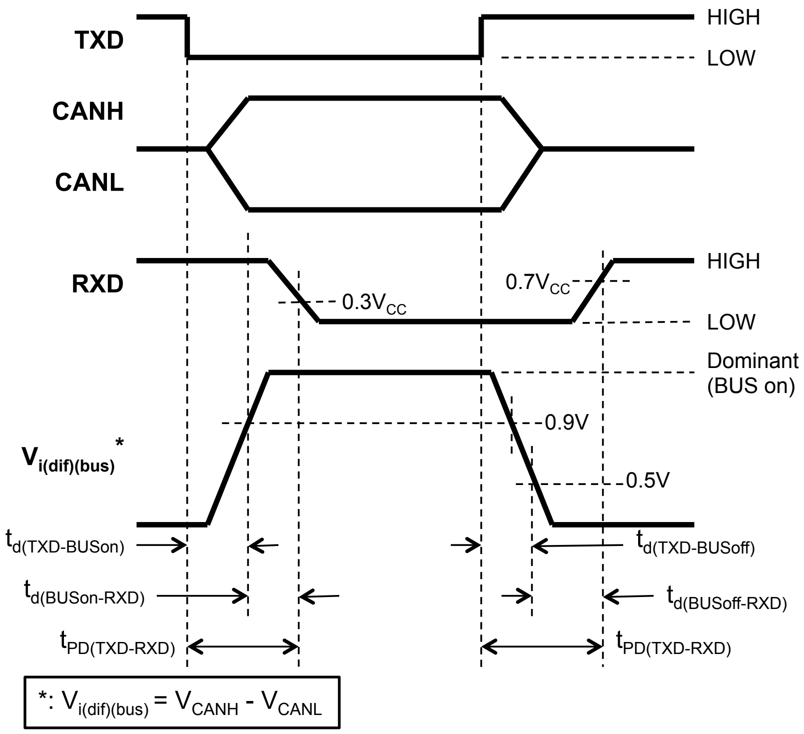


Figure 4: Timing Diagram

FUNCTIONAL DESCRIPTION

Operating Modes

The STC1040 provides 2 modes of operation which are selectable via pin STB. See *Table 1* for a description of the modes of operation.

Table 1: Operating Modes

Mode	STB Pin	RXD Pin	
		LOW	HIGH
Normal mode	LOW	Bus dominant	Bus recessive
Standby mode	HIGH	Wake-up request detected	No wake-up request detected

Normal mode

In this mode the transceiver is able to transmit and receive data via the bus line CANH and CANL. See the *Internal Schematic Diagram*. The differential receiver converts the analog data on the bus lines into digital data which is output to RXD pin via the multiplexer (MUX). The slope of the output signals on the bus lines is fixed and optimized in a way that lowest Electro-Magnetic Emission (EME) is guaranteed.

Standby mode

In this mode the transmitter and receiver are switched off, and the low-power differential receiver will monitor the bus lines.

The supply current on V_{CC} is reduced to a minimum in such a way that Electro-Magnetic Immunity (EMI) is guaranteed and a wake-up event on the bus lines will be recognized.

In this mode the bus lines are terminated to ground to reduce the supply current (I_{CC}) to a minimum. A diode is added in series with the high-side driver of RXD to prevent a reverse current from RXD to V_{CC} in the unpowered state. In normal mode this diode is bypassed. This diode is not bypassed in stanby mode to reduce current consumption.

Split Circuit

Pin SPLIT provides a DC stabilized voltage 0f $0.5V_{CC}$. It is turned on only in normal mode. In standby mode pin SPLIT is floating. The V_{SPLIT} circuit can be connecting pin SPLIT to the center tap of the split termination (See *Figure 5*). In case of a recessive bus voltage < $0.5V_{CC}$ due to the presence of an unsupplied transceiver in the network with a significant leakage current from the bus lines to ground, the split circuit will stabilize this recessive voltage to $0.5V_{CC}$. So a start of transmission does not cause a step in the common-mode signal which would lead to poor Electro-Magnetic Emission (EME) behavior.

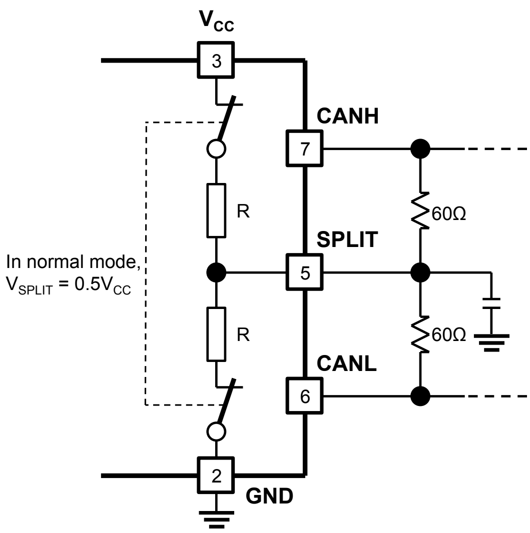


Figure 5: Stabilization Circuitry and Application

Wake-Up

In the standby mode the bus lines are monitored via a low-power differential comparator. Once the low-power differential comparator has detected a dominant bus level for more than t_{BUS}, pin RXD will become LOW.

Over-Temperature Detection

The output drivers are protected against over-temperature conditions. If the virtual junction temperature exceeds the shutdown junction temperature $T_{J(sd)}$, the output drivers will be disabled until the virtual junction temperature becomes lower than $T_{J(sd)}$ and TXD becomes recessive again.
By including the TXD condition, the occurrence of output driver oscillation due to temperature drifts is avoided.

TXD Dominant Time-Out Function

A "TXD dominant time-out" timer circuit prevents the bus lines from being driven to a permanent dominant state (blocking all network communication) if pin TXD is forced permanently LOW by a hardware and/or software application failure. The timer is triggered by a negative edge on TXD pin.
If the duration of the LOW level on TXD pin exceeds the internal timer value (t_{dom}), the transmitter is disabled, driving the bus lines into a recessive state. The timer is reset by a positive edge on TXD pin. The TXD dominant time-out time t_{dom} defines the minimum possible bit rate of 40kBaud.

Fail-Safe Features

Pin TXD provides a pull-up towards V_{CC} in order to force a recessive level in case TXD pin is unsupplied.
Pin STB provides a pull-up towards V_{CC} in order to force the transceiver into standby mode in case STB pin is unsupplied.
In the event that the V_{CC} is lost, pins TXD, STB and RXD will become floating to prevent reverse supplying conditions via these pins.

TYPICAL APPLICATION CIRCUIT

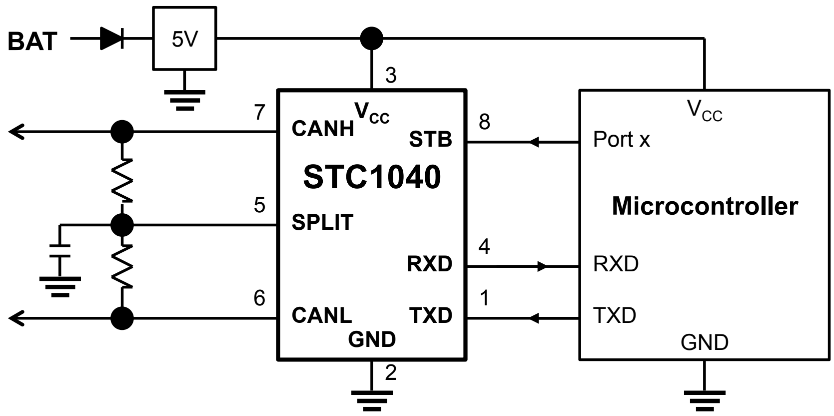


Figure 6: Typical Application for 5V Microcontroller

PACKAGE DIMENSION

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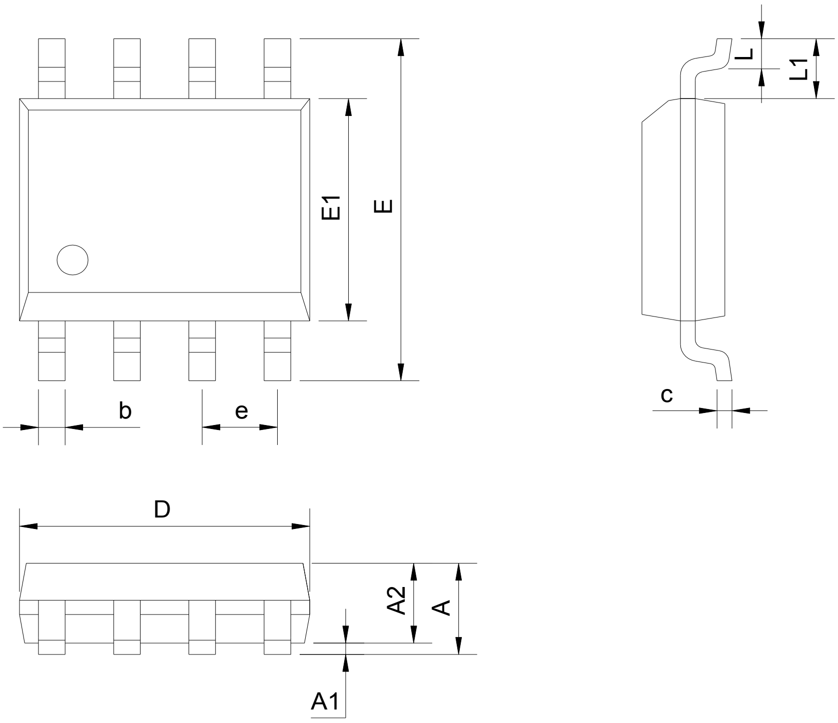

SYMBOL	Dimensions in Millimeters		Dimensions in Inches	
	MIN	MAX	MIN	MAX
A		1.750		0.069
A1	0.050	0.230	0.002	0.090
A2	1.300	1.500	0.051	0.059
b	0.350	0.450	0.014	0.018
c	0.180	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E1	3.700	4.100	0.146	0.161
E	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	0.800	0.016	0.031