MCP2025

LIN Transceiver with Voltage Regulator

Features:

- Compliant with LIN Bus Specifications Version 1.3, 2.1 and with SAE J2602-2
- Supports Baud Rates up to 20 kBaud
- 43V Load Dump Protected
- Maximum Continuous Input Voltage: 30V
- Wide LIN-Compliant Supply Voltage: 6.0-18.0V
- Extended Temperature Range: -40°C to +125°C
- Interface to PIC® EUSART and Standard USARTs
- Wake-Up on LIN Bus Activity or Local Wake Input
- Local Interconnect Network (LIN) Bus Pin:
  - Internal Pull-Up Termination Resistor and Diode for Slave Node
  - Protected Against V_{BAT} Shorts
  - Protected Against Loss of Ground
  - High-Current Drive
- T_{XD} and LIN Bus Dominant Time-Out Function
- Two Low-Power Modes:
  - Transmitter Off: 90 µA (typical)
  - Power Down: 4.5 µA (typical)
- MCP2025 On-Chip Voltage Regulator:
  - Output Voltage of 5.0V or 3.3V at 70 mA Capability with Tolerances of ±3% Over the Temperature Range
  - Internal Short-Circuit Current Limit
  - External Components Limited to Filter Capacitor and Load Capacitor
- Automatic Thermal Shutdown
- High Electromagnetic Immunity (EMI), Low Electromagnetic Emission (EME)
- Robust ESD Performance: ±15 kV for L_{BUS} and V_{BB} Pin (IEC61000-4-2)
- Transient Protection for L_{BUS} and V_{BB} pins in Automotive Environment (ISO7637)
- Meets Stringent Automotive Design Requirements, including “OEM Hardware Requirements for LIN, CAN and FlexRay Interfaces in Automotive Applications”, Version 1.3, May 2012
- Multiple Package Options, Including Small 4x4 mm DFN Package

Description:

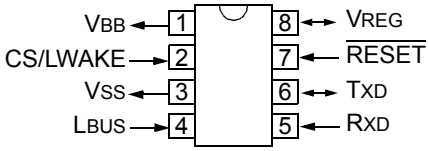
The MCP2025 provides a bidirectional, half-duplex communication physical interface to meet the LIN bus specification Revision 2.1 and SAE J2602-2. The device incorporates a voltage regulator with 5V or 3.3V at 70 mA regulated power supply output. The device has been designed to meet the stringent quiescent current requirements of the automotive industry, and will survive +43V load dump transients and double battery jumps.

The MCP2025 family members include:

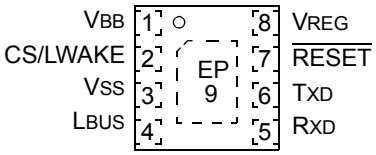
- MCP2025-500, 8-pin, LIN driver with 5.0V regulator
- MCP2025-330, 8-pin, LIN driver with 3.3V regulator

Package Types

MCP2025
PDIP, SOIC

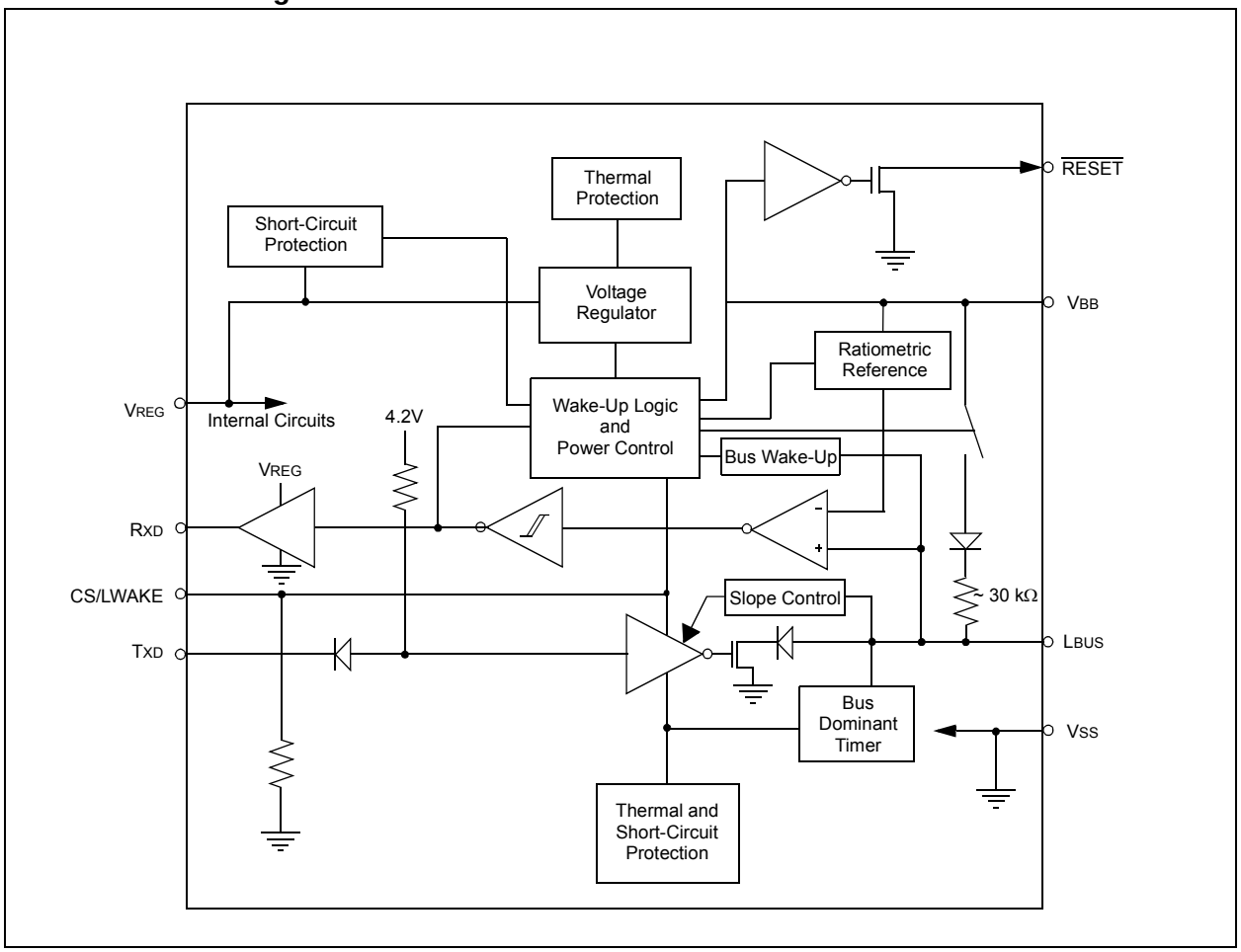


MCP2025
4x4 DFN



LOCAL INTERCONNECT NETWORK

MCP2025 Block Diagram



1.0 DEVICE OVERVIEW

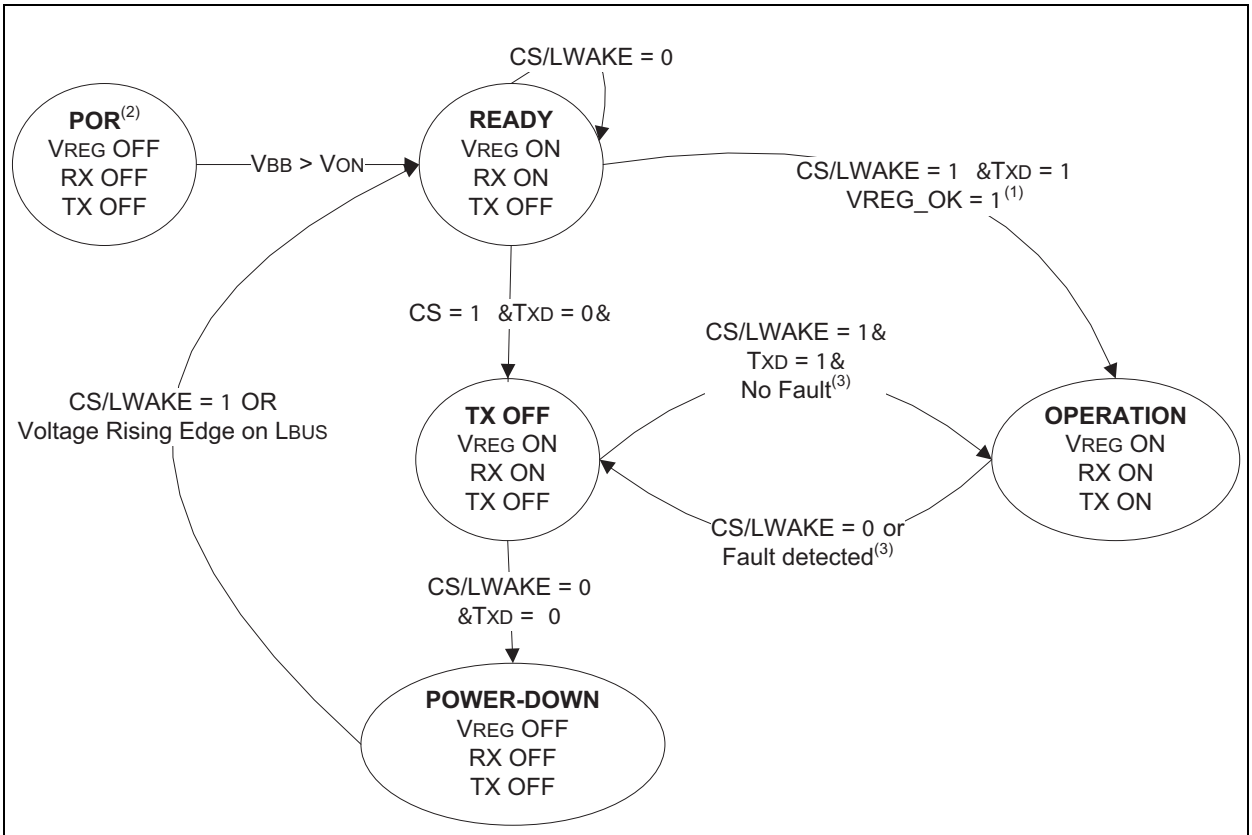
The MCP2025 provides a physical interface between a microcontroller and a LIN half-duplex bus. It is intended for automotive and industrial applications with serial bus baud rates up to 20 kBaud. This device will translate the CMOS/TTL logic levels to LIN logic levels, and vice versa.

The device offers optimum EMI and ESD performance and it can withstand high voltage on the LIN bus. The device supports two low-power modes to meet automotive industry power consumption requirements. The MCP2025 also provides a +5V or 3.3V regulated power output at 70 mA.

1.1 Modes of Operation

The MCP2025 works in five modes: Power-On Reset, Power-Down, Ready, Operation and Transmitter Off. For an overview of all operational modes, please refer to Table 1-1. For the operational mode transition, please refer to Figure 1-1.

FIGURE 1-1: STATE DIAGRAM



Note 1: VREG_OK: Regulator Output Voltage > 0.8VREG_NOM.

2: If the voltage on pin VBB falls below VOFF, the device will enter Power-On Reset mode from all other modes, which is not shown in the figure.

3: Faults include TXD/LBUS permanent dominant, LBUS short to VBB, thermal protection and VREG_OK is false.

1.1.1 POWER-ON RESET MODE

Upon application of V_{BB}, or whenever the voltage on V_{BB} is below the threshold of regulator turn-off voltage V_{OFF} (typically 4.50V), the device enters Power-On Reset (POR) mode. During this mode, the device maintains the digital section in a Reset mode and waits until the voltage on the V_{BB} pin rises above the threshold of regulator turn-on voltage V_{ON} (typically 5.75V) to enter Ready mode. In Power-On Reset mode, the LIN physical layer and voltage regulator are disabled and the $\overline{RESET}$ pin is switched to ground.

1.1.2 READY MODE

The device enters Ready mode from POR mode after the voltage on V_{BB} rises above the threshold of regulator turn-on voltage V_{ON}, or from Power-Down mode when a remote or local wake-up event happens.

Upon entering Ready mode, the voltage regulator and the receiver section of the transceiver are powered-up. The transmitter remains in an off state. The device is ready to receive data, but not to transmit. In order to minimize the power consumption, the regulator operates in a reduced-power mode. It has a lower GBW product and it is thus slower. However, the 70 mA drive capability is unchanged.

The device stays in Ready mode until the output of the voltage regulator has stabilized and the CS/LWAKE pin is high ('1').

1.1.3 OPERATION MODE

If the CS/LWAKE pin changes to high while V_{REG} is OK (V_{REG} > 0.8*V_{REG_NOM}) and the T_{XD} pin is high, the part enters Operation mode from either Ready or Transmitter Off mode.

In this mode, all internal modules are operational. The internal pull-up resistor between L_{BUS} and V_{BB} is connected only in this mode.

The device goes into Transmitter Off mode at the falling edge on the CS/LWAKE pin or when a fault is detected.

Note:	The T_{XD} pin needs to be set high before setting the CS/LWAKE pin to low in order to jump and stay in Transmitter Off mode. If the T_{XD} pin is set or maintained low before setting the CS/LWAKE pin to low, the part will transition to Transmitter Off mode and then jump to Power-Down mode after a deglitch delay of about 20 µs.

1.1.4 TRANSMITTER OFF MODE

If V_{REG} is OK (V_{REG} > 0.8*V_{REG_NOM}), the Transmitter Off mode can be reached from Ready mode by setting CS/LWAKE to high when the T_{XD} pin is low, or from Operation mode by pulling down CS/LWAKE to low.

In Transmitter Off mode, the receiver is enabled but the L_{BUS} transmitter is off. It is a lower-power mode.

In order to minimize power consumption, the regulator operates in a reduced-power mode. It has a lower GBW product and it is thus slower. However, the 70 mA drive capability is unchanged.

The transmitter is also turned off whenever the voltage regulator is unstable or recovering from a fault. This prevents unwanted disruption on the bus during times of uncertain operation.

1.1.5 POWER-DOWN MODE

Power-Down mode is entered by pulling down both the CS/LWAKE pin and the T_{XD} pin to low from Transmitter Off mode. In Power-Down mode, the transceiver and the voltage regulator are both off. Only the bus wake-up section and the CS/LWAKE pin wake-up circuits are in operation. This is the lowest-power mode.

If any bus activity (e.g., a Break character) occurs or CS/LWAKE is set to high during Power-Down mode, the device will immediately enter Ready mode and enable the voltage regulator. Then, once the regulator output has stabilized (approximately 0.3 ms to 1.2 ms), it can go into either Operation mode or Transmitter Off mode. Refer to **Section 1.1.6 "Remote Wake-Up"** for more details.

1.1.6 REMOTE WAKE-UP

The Remote Wake-Up sub-module observes the L_{BUS} in order to detect bus activity. In Power-Down mode, the normal LIN recessive/dominant threshold is disabled and the LIN bus wake-up voltage threshold $V_{WK(LBUS)}$ is used to detect bus activities. Bus activity is detected when the voltage on the L_{BUS} falls below the LIN bus wake-up voltage threshold $V_{WK(LBUS)}$ (approximately 3.4V) for at least t_{BDB} (a typical duration of 80 µs) followed by a rising edge. Such a condition causes the device to leave Power-Down mode.

TABLE 1-1: OVERVIEW OF OPERATIONAL MODES

State	Transmitter	Receiver	Internal Wake Module	Voltage Regulator	Operation	Comments
POR	OFF	OFF	OFF	OFF	Proceed to Ready mode after $V_{BB} > V_{ON}$.	—
Ready	OFF	ON	OFF	ON	If CS/LWAKE is high, then proceed to Operation or Transmitter Off mode.	Bus Off state
Operation	ON	ON	OFF	ON	If CS/LWAKE is low, then proceed to Transmitter Off mode.	Normal Operation mode
Power-Down	OFF	OFF	ON Activity Detect	OFF	On LIN bus rising edge or CS/LWAKE high level, go to Ready mode.	Lowest-Power mode
Transmitter Off	OFF	ON	OFF	ON	If T_{XD} and CS/LWAKE are low, then proceed to Power-Down mode. If T_{XD} and CS/LWAKE are high, then proceed to Operation mode.	Bus Off state, lower-power mode

1.2 Pin Descriptions

The descriptions of the pins are listed in Table 1-2.

TABLE 1-2: PIN FUNCTION TABLE

Pin Name	Pin Number		Pin Type	Description
	8-lead PDIP	4x4 DFN		
VBB	1	1	Power	Battery
CS/LWAKE	2	2	TTL input, HV-tolerant	Chip Select and Local Wake-up Input
VSS	3	3	Power	Ground
LBUS	4	4	I/O, HV	LIN Bus
RXD	5	5	Output	Receive Data Output
TXD	6	6	Input, HV-tolerant	Transmit Data Input
$\overline{\text{RESET}}$	7	7	Open-drain output, HV-tolerant	Reset Output
VREG	8	8	Output	Voltage Regulator Output
EP	—	9	—	Exposed Thermal Pad

1.2.1 BATTERY POSITIVE SUPPLY VOLTAGE (VBB)

Battery Positive Supply Voltage pin. An external diode is connected in series to prevent the device from being reversely powered (refer to Figure 1-7).

1.2.2 CHIP SELECT AND LOCAL WAKE-UP INPUT (CS/LWAKE)

Chip Select and Local Wake-Up Input pin (TTL level, high-voltage tolerant). This pin controls the device state transition. Refer to Figure 1-1.

An internal pull-down resistor will keep the CS/LWAKE pin low to ensure that no disruptive data will be present on the bus while the microcontroller is executing a Power-On Reset and I/O initialization sequence. When CS/LWAKE is '1', a weak pull-down (~600 kΩ) is used to reduce current. When CS/LWAKE is '0', a stronger pull-down (~300 kΩ) is used to maintain the logic level.

This pin may also be used as a local wake-up input (see Figure 1-7). The microcontroller will set the I/O pin to control the CS/LWAKE. An external switch or another source can then wake up both the transceiver and the microcontroller.

Note:	CS/LWAKE should NOT be tied directly to the VREG pin, as this could force the MCP2025 into Operation mode before the microcontroller is initialized.

1.2.3 GROUND (VSS)

Ground pin.

1.2.4 LIN BUS (LBUS)

LIN Bus pin. LBUS is a bidirectional LIN bus interface pin and is controlled by the signal TXD. It has an open collector output with a current limitation. To reduce electromagnetic emission, the slopes during signal changes are controlled and the LBUS pin has corner-rounding control for both falling and rising edges.

The internal LIN receiver observes the activities on the LIN bus and generates the output signal RXD that follows the state of the LBUS. A 1st degree 160 kHz low-pass input filter optimizes electromagnetic immunity.

1.2.5 RECEIVE DATA OUTPUT (RXD)

Receive Data Output pin. The RXD pin is a standard CMOS output pin and it follows the state of the LBUS pin.

1.2.6 TRANSMIT DATA INPUT (TXD)

Transmit Data Input pin (TTL level, HV-compliant, adaptive pull-up). The transmitter reads the data stream on the TXD pin and sends it to the LIN bus. The LBUS pin is low (dominant) when TXD is low, and high (recessive) when TXD is high.

TXD is internally pulled-up to approximately 4.2V. When TXD is '0', a weak pull-up (~900 kΩ) is used to reduce current. When TXD is '1', a stronger pull-up (~300 kΩ) is used to maintain the logic level. A series reverse-blocking diode allows applying TXD input voltages greater than the internally generated 4.2V and renders the TXD pin HV-compliant up to 30V (see MCP2025 Block Diagram).

1.2.7 $\overline{\text{RESET}}$

Reset output pin. This is an open-drain output pin. It indicates the internal voltage has reached a valid, stable level. As long as the internal voltage is valid (above 0.8 VREG), this pin will present high impedance; otherwise, the $\overline{\text{RESET}}$ pin switches to ground.

1.2.8 POSITIVE SUPPLY VOLTAGE REGULATOR OUTPUT (VREG)

Positive Supply Voltage Regulator Output pin. An on-chip Low Dropout Regulator (LDO) gives +5.0 or +3.3V at 70 mA regulated voltage on this pin.

1.2.9 EXPOSED THERMAL PAD (EP)

There is an internal electrical connection between the Exposed Thermal Pad (EP) and the VSS pin; they must be connected to the same potential on the Printed Circuit Board (PCB).

This pad can be connected to a PCB ground plane to provide a larger heat sink. This improves the package thermal resistance (θJA).

1.3 Fail-Safe Features

1.3.1 GENERAL FAIL-SAFE FEATURES

- An internal pull-down resistor on the CS/LWAKE pin disables the transmitter if the pin is floating.
- An internal pull-up resistor on the TXD pin places TXD in high and the LBUS in recessive if the TXD pin is floating.
- High-Impedance and low-leakage current on LBUS during loss of power or ground.
- The current limit on LBUS protects the transceiver from being damaged if the pin is shorted to VBB.

1.3.2 THERMAL PROTECTION

The thermal protection circuit monitors the die temperature and is able to shut down the LIN transmitter and voltage regulator.

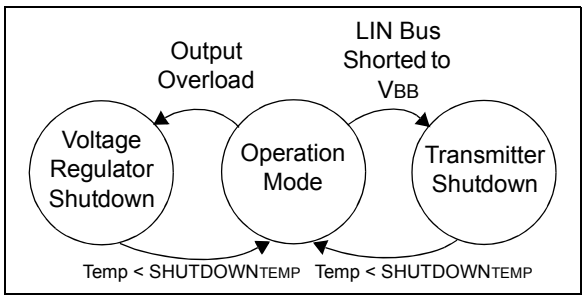
There are three causes for a thermal overload. A thermal shutdown can be triggered by any one, or a combination of, the following thermal overload conditions:

- Voltage regulator overload
- LIN bus output overload
- Increase in die temperature due to increase in environment temperature

The recovery time from the thermal shutdown is equal to adequate cooling time.

Driving the TXD and checking the RXD pin make it possible to determine whether there is a bus contention (TXD = high, RXD = low) or a thermal overload condition (TXD = low, RXD = high).

FIGURE 1-2: THERMAL SHUTDOWN STATE DIAGRAMS



1.3.3 TXD/LBUS TIME-OUT TIMER

The LIN bus can be driven to a dominant level, either from the TXD pin or externally. An internal timer deactivates the LBUS transmitter if a dominant status (low) on the LIN bus lasts longer than Bus Dominant Time-Out Time, tTO(LIN) (approximately 20 milliseconds). At the same time, the RXD output is put in recessive (high) and the internal pull-up resistor between LBUS and VBB is disconnected. The timer is reset on any recessive LBUS status or POR mode. The recessive status on LBUS can be caused either by the bus being externally pulled-up or by the TXD pin being returned high.

1.4 Internal Voltage Regulator

The MCP2025 has a positive regulator capable of supplying +5.00 or +3.30 VDC ±3% at up to 70 mA of load current over the entire operating temperature range of -40°C to +125°C. The regulator uses an LDO design, is short-circuit-protected and will turn the regulator output off if its output falls below the shutdown voltage threshold, VSD.

With a load current of 70 mA, the minimum input-to-output voltage differential required for the output to remain in regulation is typically +0.5V (+1V maximum over the full operating temperature range). Quiescent current is less than 100 µA with a full 70 mA load current when the input-to-output voltage differential is greater than +3.00V.

Regarding the correlation between VBB, VREG and IDD, please refer to Figures 1-4 and 1-5. When the input voltage (VBB) drops below the differential needed to provide stable regulation, the voltage regulator output, VREG, will track the input down to approximately VOFF, at which point the regulator will turn off the output. This will allow PIC® microcontrollers with internal POR circuits to generate a clean arming of the POR trip point. The MCP2025 will then monitor VBB and turn on the regulator when VBB is above the threshold of regulator turn-on voltage, VON.

In Power-Down mode, the VBB monitor is turned off.

Under specific ambient temperature and battery voltage range, the voltage regulator can output as high as 150 mA current. For current load capability of the voltage regulator, refer to Figures 2-8 and 2-9.

Note: The regulator has an overload current limit of approximately 250 mA. The regulator output voltage, V_{REG}, is monitored. If output voltage V_{REG} is lower than V_{SD}, the voltage regulator will turn off. After a recovery time of about 3 ms, the V_{REG} will be checked again. If there is no short circuit, ($V_{REG} > V_{SD}$), then the voltage regulator remains on.

The regulator requires an external output bypass capacitor for stability. See Figure 2-1 for correct capacity and ESR for stable operation.

Note: A ceramic capacitor of at least 10 µF or a tantalum capacitor of at least 2.2 µF is recommended for stability.

In worst-case scenarios, the ceramic capacitor may derate by 50%, based on tolerance, voltage and temperature. Therefore, in order to ensure stability, ceramic capacitors smaller than 10 µF may require a small series resistance to meet the ESR requirements, as shown in Table 1-3.

TABLE 1-3: RECOMMENDED SERIES RESISTANCE FOR CERAMIC CAPACITORS

Resistance	Capacitor
1Ω	1 µF
0.47Ω	2.2 µF
0.22Ω	4.7 µF
0.1Ω	6.8 µF

FIGURE 1-3: VOLTAGE REGULATOR BLOCK DIAGRAM

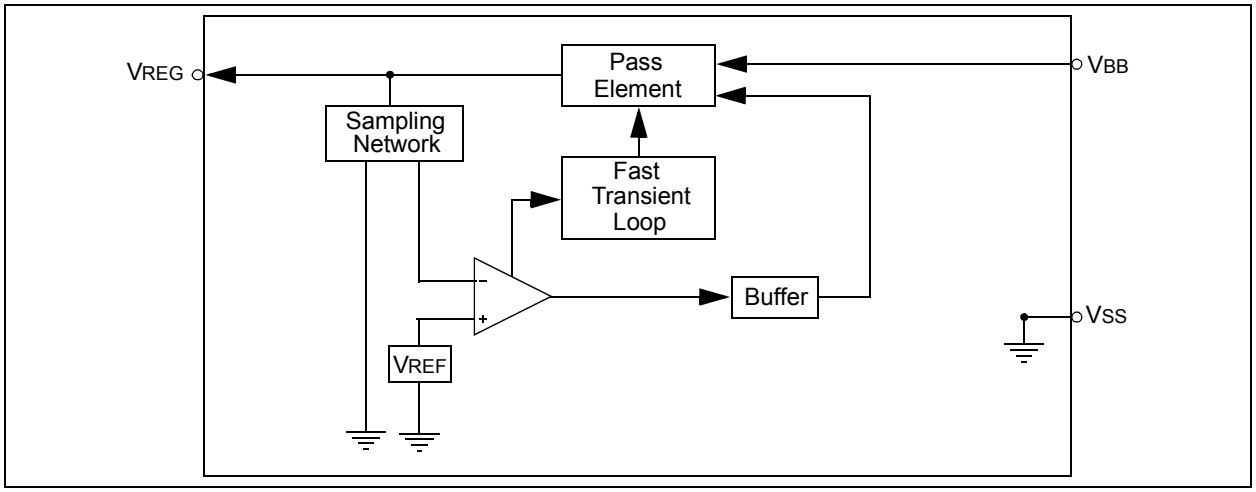
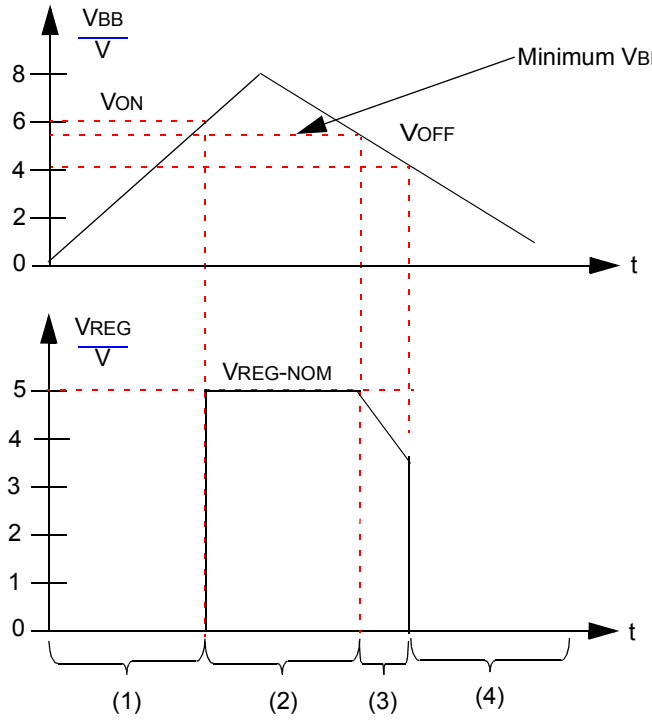
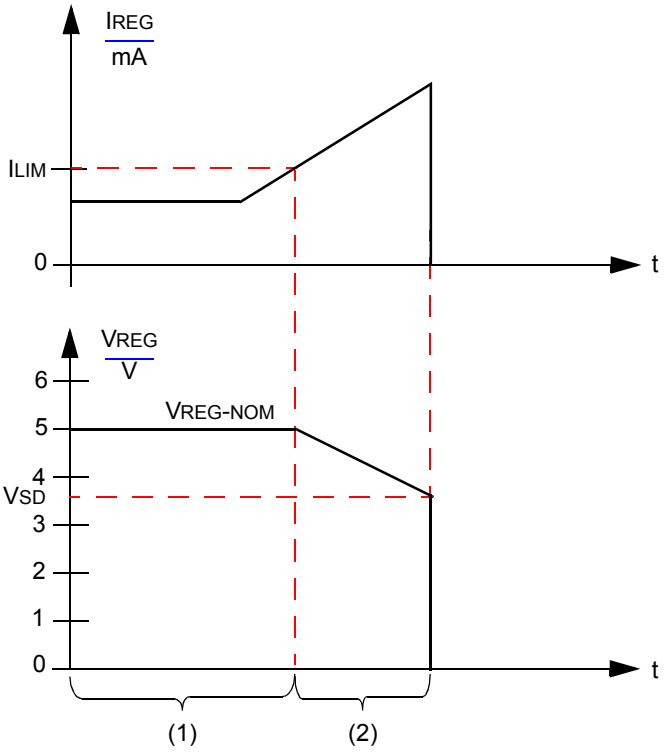


FIGURE 1-4: VOLTAGE REGULATOR OUTPUT ON POWER-ON RESET



Note 1: V_{BB} < V_{ON}, regulator off.
2: V_{BB} > V_{ON}, regulator on.
3: $V_{BB} \leq$ Minimum V_{BB} to maintain regulation.
4: V_{BB} < V_{OFF}, regulator will turn off.

FIGURE 1-5: VOLTAGE REGULATOR OUTPUT ON OVERCURRENT SITUATION



Note 1: I_{REG} less than I_{LIM}, regulator on.
2: After I_{REG} exceeds I_{LIM}, the voltage regulator output will be reduced until V_{SD} is reached.

1.5 Optional External Protection

1.5.1 REVERSE BATTERY PROTECTION

An external reverse-battery-blocking diode should be used to provide polarity protection (see Figure 1-7).

1.5.2 TRANSIENT VOLTAGE PROTECTION (LOAD DUMP)

An external 43V transient suppressor (TVS) diode, between VBB and ground, with a transient protection resistor (RTP) in series with the battery supply and the VBB pin, protects the device from power transients and ESD events greater than 43V (see Figure 1-7). The maximum value for the RTP protection resistor depends upon two parameters: the minimum voltage the part will start at and the impacts of this RTP resistor on the VBB value, thus on the bus recessive level and slopes.

This leads to a set of three equations to fulfill.

Equation 1-1 provides a maximum RTP value according to the minimum battery voltage the user wants.

Equation 1-2 provides a maximum RTP value according to the maximum error on the recessive level, thus VBB, since the part uses VBB as the reference value for the recessive level.

Equation 1-3 provides a maximum RTP value according to the maximum relative variation the user can accept on the slope when IREG varies.

Since both Equations 1-1 and 1-2 must be fulfilled, the maximum allowed value for RTP is thus the smaller of the two values found when solving Equations 1-1 and 1-2.

Usually, Equation 1-1 gives the higher constraint (smaller value) for RTP, as shown in the following example where VBATMIN is 8V.

However, the user needs to verify that the value found with Equation 1-1 fulfills Equations 1-2 and 1-3.

While this protection is optional, it should be considered as good engineering practice.

EQUATION 1-1:

$$R_{TP} \leq \frac{V_{BATMIN} - 5.5V}{250\ mA}$$

$$5.5V = V_{OFF} + 1.0V$$

Where:

250 mA = Peak current at power-on when VBB = 5.5V

Assume that VBATMIN = 8V. Equation 1-1 gives 10Ω.

EQUATION 1-2:

$$R_{TP} \leq \frac{\Delta V_{RECESSIVE}}{I_{REGMAX}}$$

Where:

ΔVRECESSIVE = Maximum variation tolerated on the recessive level

Assume that ΔVRECCESSIVE = 1V and IREGMAX = 50 mA. Equation 1-2 gives 20Ω.

EQUATION 1-3:

$$R_{TP} \leq \frac{\Delta Slope \times (V_{BATMIN} - 1V)}{I_{REGMAX}}$$

Where:

ΔSlope = Maximum variation tolerated on the slope level

IREGMAX = Maximum current the current will provide to the load

VBATMIN > VOFF + 1.0V

Assume that ΔSlope = 15%, VBATMIN = 8V and IREGMAX = 50 mA. Equation 1-3 gives 20Ω.

1.5.3 CBAT CAPACITOR

Selecting CBAT = 10 x CREG is recommended. However, this leads to a high-value capacitor. Lower values for CBAT capacitor can be used with respect to some rules. In any case, the voltage at the VBB pin should remain above VOFF when the device is turned on.

The current peak at start-up (due to the fast charge of the CREG and CBAT capacitors) may induce a significant drop on the VBB pin. This drop is proportional to the impedance of the VBAT connection (see Figure 1-7).

The VBAT connection is mainly inductive and resistive. Therefore, it can be modeled as a resistor (RTOT) in series with an inductor (L). RTOT and L can be measured.

The following formula gives an indication of the minimum value of CBAT using RTOT and L:

EQUATION 1-4:

$$\frac{C_{BAT}}{C_{REG}} = \sqrt{\frac{100L^2 + R_{TOT}^2}{1 + L^2 + \frac{R_{TOT}^2}{100}}}$$

Where:

L = Inductor (measured in mH)

RTOT = RLINE + RTP (measured in Ω)

Equation 1-4 allows lower CBAT/CREG values than the 10x ratio we recommend.

Assume that we have a good quality VBAT connection with RTOT = 0.1Ω and L = 0.1 mH.

Solving the equation gives CBAT/CREG = 1.

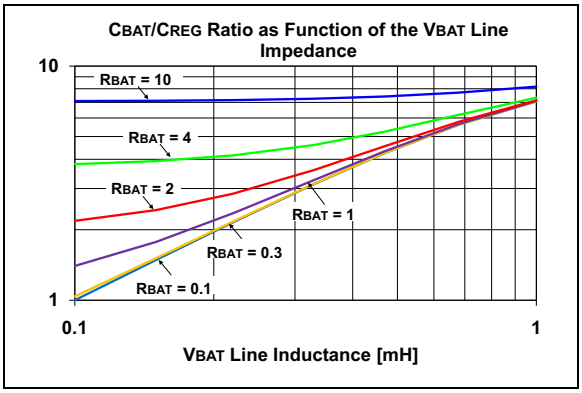
If we increase RTOT up to 1Ω, the result becomes CBAT/CREG = 1.4. However, if the connection is highly resistive or highly inductive (poor connection), the CBAT/CREG ratio greatly increases.

TABLE 1-4: CBAT/CREG RATIO BY VBAT CONNECTION TYPE

Connection Type	RTOT	L	CBAT/CREG Ratio
Good	0.1Ω	0.1 mH	1
Typical	1Ω	0.1 mH	1.4
Highly inductive	0.1Ω	1 mH	7
Highly resistive	10Ω	0.1 mH	7

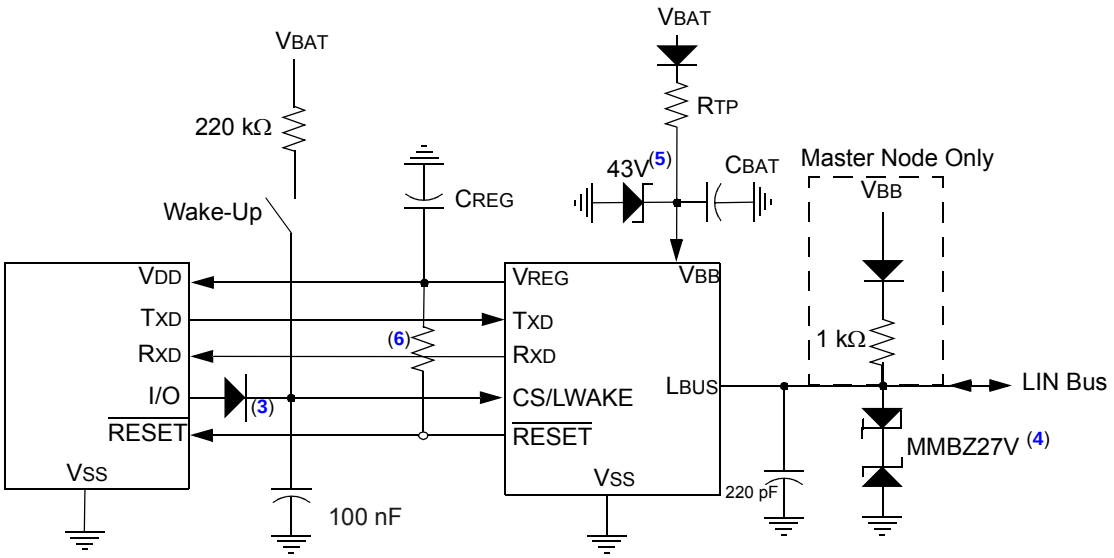
Figure 1-6 shows the minimum recommended CBAT/CREG ratio as a function of the impedance of the VBAT connection.

FIGURE 1-6: Minimum Recommended CBAT/CREG Ratio



1.6 Typical Applications

FIGURE 1-7: TYPICAL APPLICATION CIRCUIT



Note 1: CREG, the load capacitor, should be ceramic or tantalum rated for extended temperatures, 1.0-22 µF. See Figure 2-1 to select the correct ESR.

2: CBAT is the filter capacitor for the external voltage supply. Typically 10 x CREG, with no ESR restriction. See Figure 1-6 to select the minimum recommended value for CBAT. The RTP value is added to the line resistance.

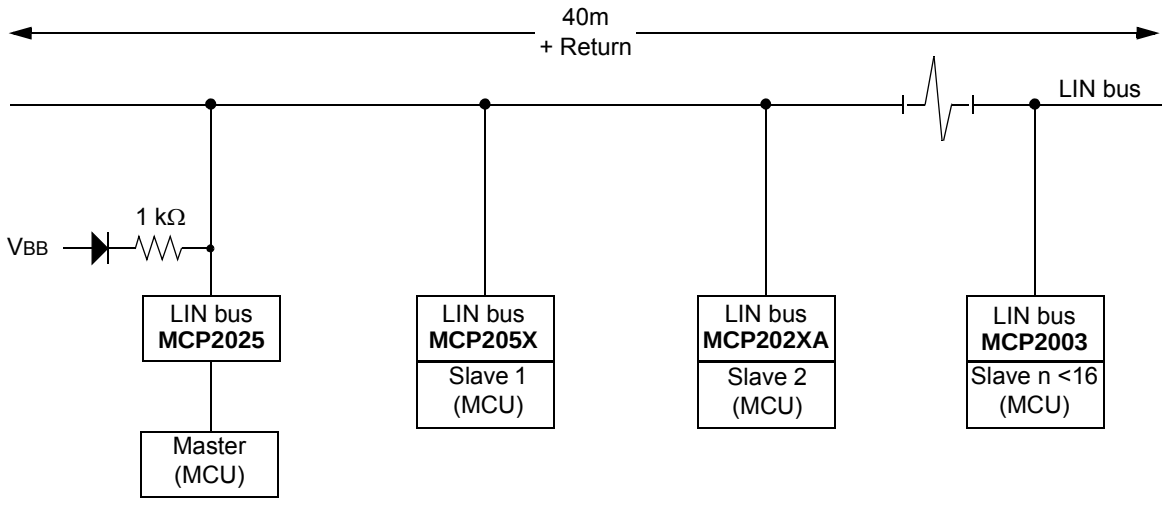
3: This diode is only needed if CS/LWAKE is connected to the VBAT supply.

4: ESD protection diode.

5: This component is for additional load dump protection.

6: An external 10 kΩ resistor is recommended for some applications.

FIGURE 1-8: TYPICAL LIN NETWORK CONFIGURATION



1.7 ICSP™ Considerations

The following should be considered when the MCP2025 are connected to pins supporting in-circuit programming:

- Power used for programming the microcontroller can be supplied from the programmer or from the MCP2025.

The voltage on the VREG pin should not exceed the maximum value of VREG in DC Specifications.

2.0 ELECTRICAL CHARACTERISTICS

2.1 Absolute Maximum Ratings†

V_{IN} DC Voltage on R_{XD} and $\overline{RESET}$ ..... -0.3V to V_{REG} + 0.3
V_{IN} DC Voltage on T_{XD}, CS/LWAKE..... -0.3 to +40V
V_{BB} Battery Voltage, continuous, non-operating (**Note 1**)..... -0.3 to +40V
V_{BB} Battery Voltage, non-operating (LIN bus recessive, no regulator load, t < 60s) (**Note 2**) ..... -0.3 to +43V
V_{BB} Battery Voltage, transient ISO 7637 Test 1 ..... -100V
V_{BB} Battery Voltage, transient ISO 7637 Test 2a .....+75V
V_{BB} Battery Voltage, transient ISO 7637 Test 3a ..... -150V
V_{BB} Battery Voltage, transient ISO 7637 Test 3b .....+100V
V_{LBUS} Bus Voltage, continuous..... -18 to +30V
V_{LBUS} Bus Voltage, transient (**Note 3**)..... -27 to +43V
I_{LBUS} Bus Short Circuit Current Limit .....200 mA
ESD protection on LIN, V_{BB} (IEC 61000-4-2) (**Note 4**).....±15 V
ESD protection on LIN, V_{BB} (Human Body Model) (**Note 5**).....±8 kV
ESD protection on all other pins (Human Body Model) (**Note 5**) .....±4 kV
ESD protection on all pins (Charge Device Model) (**Note 6**).....±1500V
ESD protection on all pins (Machine Model) (**Note 7**).....±200V
Maximum Junction Temperature .....150°C
Storage Temperature.....-65 to +150°C

† **Notice:** Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

Note 1: LIN 2.x compliant specification.

2: SAE J2602-2 compliant specification.

3: ISO 7637/1 load dump compliant (t < 500 ms).

4: According to IEC 61000-4-2, 330Ω, 150 pF and Transceiver EMC Test Specifications [2] to [4].

5: According to AEC-Q100-002/JESD22-A114.

6: According to AEC-Q100-011B.

7: According to AEC-Q100-003/JESD22-A115.

2.2 Nomenclature Used in this Document

Some terms and names used in this data sheet deviate from those referred to in the LIN specifications. Equivalent values are shown below.

LIN 2.1 Name	Term used in the following tables	Definition
V_{BAT}	*not used*	ECU operating voltage
V_{SUP}	V_{BB}	Supply voltage at device pin
V_{BUS_LIM}	I_{SC}	Current limit of driver
V_{BUSREC}	$V_{IH(LBUS)}$	Recessive state
V_{BUSDOM}	$V_{IL(LBUS)}$	Dominant state

2.3 DC Specifications

DC Specifications	**Electrical Characteristics:** Unless otherwise indicated, all limits are specified for V_{BB} = 6.0V to 18.0V, T_A = -40°C to +125°C, C_{REG} = 10 µF.					
Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Power						
V_{BB} Quiescent Operating Current	I_{BBQ}	—	—	200	µA	I_{OUT} = 0 mA LBUS recessive V_{REG} = 5.0V
		—	—	200	µA	I_{OUT} = 0 mA LBUS recessive V_{REG} = 3.3V
V_{BB} Ready Current	I_{BBRD}	—	—	100	µA	I_{OUT} = 0 mA LBUS recessive V_{REG} = 5.0V
		—	—	100	µA	I_{OUT} = 0 mA LBUS recessive V_{REG} = 3.3V
V_{BB} Transmitter-Off Current with Watchdog Disabled	I_{BBTO}	—	—	100	µA	With voltage regulator on, transmitter off, receiver on, CS = V_{IH},V_{REG} = 5.0V
		—	—	100	µA	With voltage regulator on, transmitter off, receiver on, CS = V_{IH},V_{REG} = 3.3V
V_{BB} Power-Down Current	I_{BBPD}	—	4.5	8	µA	With voltage regulator off, receiver on and transmitter off, CS = V_{IL}
V_{BB} Current with V_{SS} Floating	$I_{BBNOGND}$	-1	—	1	mA	V_{BB} = 12V, GND to V_{BB}, V_{LIN} = 0 – 18V
Microcontroller Interface						
High-Level Input Voltage (TXD)	V_{IH}	2.0	—	30	V	
Low-Level Input Voltage (TXD)	V_{IL}	-0.3	—	0.8	V	
High-Level Input Current (TXD)	I_{IH}	-2.5	—	0.4	µA	Input voltage = 4.0V ~800 kΩ internal adaptive pull-up
Low-Level Input Current (TXD)	I_{IL}	-10	—	—	µA	Input voltage = 0.5V ~800 kΩ internal adaptive pull-up
High-Level Input Voltage (CS/LWAKE)	V_{IH}	2	—	30	V	Through a current-limiting resistor
Low-Level Input Voltage (CS/LWAKE)	V_{IL}	-0.3	—	0.8	V	
High-Level Input Current (CS/LWAKE)	I_{IH}	—	—	8.0	µA	Input voltage = 0.8V_{REG} ~1.3 MΩ internal pull-down to V_{SS}

Note 1: Internal current limited. 2.0 ms maximum recovery time (R_{LBUS} = 0Ω, TX = 0, V_{LBUS} = V_{BB}).

2: Characterized, not 100% tested.

3: In Power-Down mode, normal LIN recessive/dominant threshold is disabled; $V_{WK(LBUS)}$ is used to detect bus activities.

2.3 DC Specifications (Continued)

DC Specifications	**Electrical Characteristics:** Unless otherwise indicated, all limits are specified for V_{BB} = 6.0V to 18.0V, T_A = -40°C to +125°C, C_{REG} = 10 µF.					
Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Low-Level Input Current (CS/LWAKE)	I_{IL}	—	—	5.0	µA	Input voltage = 0.2V_{REG} ~1.3 MΩ internal pull-down to V_{SS}
Low-Level Output Voltage (RXD)	V_{OLRXD}	—	—	0.2V_{REG}	V	I_{OL} = 2 mA
High-Level Output Voltage (RXD)	V_{OHRXD}	0.8V_{REG}	—	—	V	I_{OH} = 2 mA
Bus Interface						
High-Level Input Voltage	$V_{IH(LBUS)}$	0.6 V_{BB}	—	—	V	Recessive state
Low-Level Input Voltage	$V_{IL(LBUS)}$	-8	—	0.4 V_{BB}	V	Dominant state
Input Hysteresis	V_{HYS}	—	—	0.175 V_{BB}	V	$V_{IH(LBUS)}$ – $V_{IL(LBUS)}$
Low-Level Output Current	$I_{OL(LBUS)}$	40	—	200	mA	Output voltage = 0.1 V_{BB}, V_{BB} = 12V
Pull-Up Current on Input	$I_{PU(LBUS)}$	-180	—	-72	µA	~30 kΩ internal pull-up @ $V_{IH(LBUS)}$ = 0.7 V_{BB}, V_{BB} = 12V
Short Circuit Current Limit	I_{SC}	50	—	200	mA	**Note 1**
High-Level Output Voltage	$V_{OH(LBUS)}$	0.8 V_{BB}	—	V_{BB}	V	
Driver Dominant Voltage	$V_{\_LOSUP}$	—	—	1.1	V	V_{BB} = 7.3V R_{LOAD} = 1000Ω
	$V_{\_HISUP}$	—	—	1.2	V	V_{BB} = 18V R_{LOAD} = 1000Ω
Input Leakage Current (at the receiver during dominant bus level)	$I_{BUS\_PAS\_DOM}$	-1	—	—	mA	Driver off V_{BUS} = 0V V_{BB} = 12V
Input Leakage Current (at the receiver during recessive bus level)	$I_{BUS\_PAS\_REC}$	-20	—	20	µA	Driver off 8V < V_{BB} < 18V 8V < V_{BUS} < 18V $V_{BUS} \geq V_{BB}$
Leakage Current (disconnected from ground)	$I_{BUS\_NO\_GND}$	-10	—	+10	µA	GND_{DEVICE} = V_{BB} 0V < V_{BUS} < 18V V_{BB} = 12V
Leakage Current (disconnected from V_{BB})	$I_{BUS\_NO\_PWR}$	-10	—	+10	µA	V_{BB} = GND 0 < V_{BUS} < 18V
Receiver Center Voltage	V_{BUS_CNT}	0.475 V_{BB}	0.5 V_{BB}	0.525 V_{BB}	V	V_{BUS_CNT} = ($V_{IL(LBUS)}$ + $V_{IH(LBUS)}$)/2
Slave Termination	R_{SLAVE}	20	30	47	kΩ	**Note 2**
Capacitance of Slave Node	C_{SLAVE}	—	—	50	pF	**Note 2**
Wake-Up Voltage Threshold on LIN Bus	$V_{WK(LBUS)}$	—	—	3.4	V	Wake up from Power-Down mode (**Note 3**)

Note 1: Internal current limited. 2.0 ms maximum recovery time (R_{LBUS} = 0Ω, TX = 0, V_{LBUS} = V_{BB}).

2: Characterized, not 100% tested.

3: In Power-Down mode, normal LIN recessive/dominant threshold is disabled; $V_{WK(LBUS)}$ is used to detect bus activities.

2.3 DC Specifications (Continued)

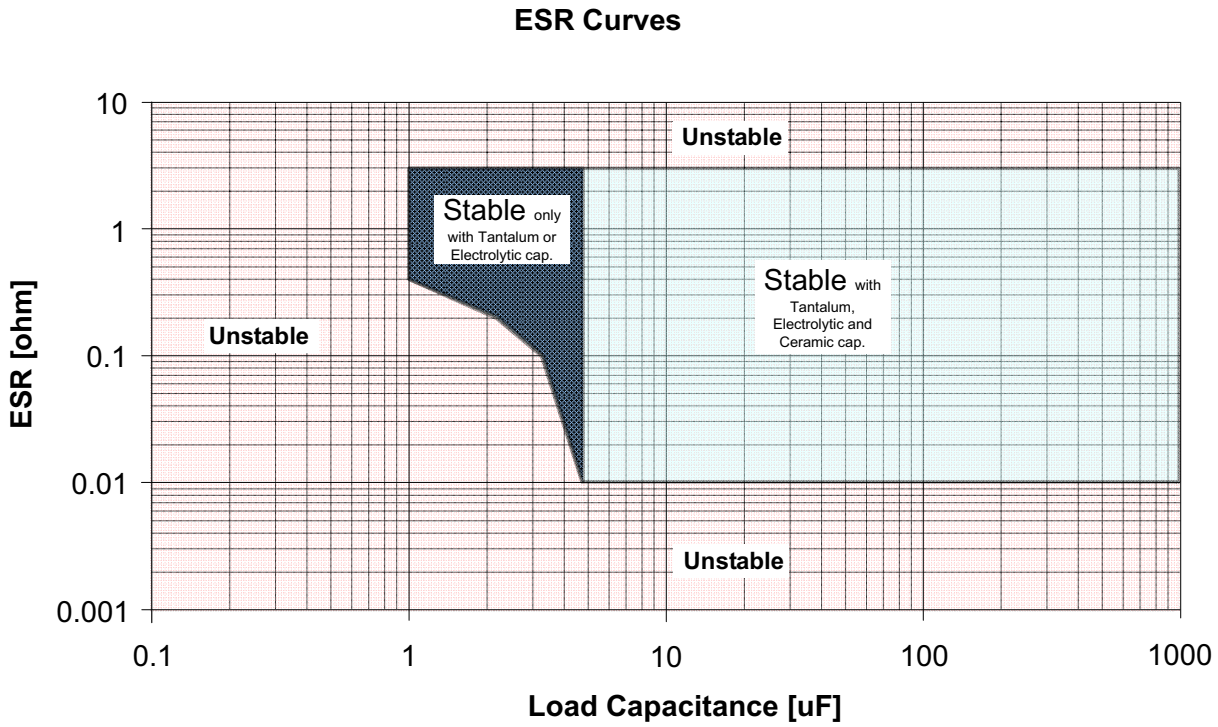
DC Specifications	**Electrical Characteristics:** Unless otherwise indicated, all limits are specified for V_{BB} = 6.0V to 18.0V, T_A = -40°C to +125°C, C_{REG} = 10 µF.					
Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Voltage Regulator – 5.0V						
Output Voltage Range	V_{REG}	4.85	5.00	5.15	V	0 mA < I_{OUT} < 70 mA
Line Regulation	$\Delta V_{OUT}1$	—	10	50	mV	I_{OUT} = 1 mA 6.0V < V_{BB} < 18V
Load Regulation	$\Delta V_{OUT}2$	—	10	50	mV	5 mA < I_{OUT} < 70 mA 6.0V < V_{BB} < 12V
Power Supply Ripple Reject	PSRR	—	—	50	dB	1 V_{PP} @ 10-20 kHz I_{LOAD} = 20 mA
Output Noise Voltage	eN	—	—	100	µV_{RMS}	10 Hz – 40 MHz C_{FILTER} = 10 µf C_{BP} = 0.1 µf I_{LOAD} = 20 mA
Shutdown Voltage Threshold	V_{SD}	3.5	—	4.0	V	See Figure 1-5 (**Note 2**)
Input Voltage to Turn-Off Output	V_{OFF}	3.9	—	4.5	V	—
Input Voltage to Turn-On Output	V_{ON}	5.25	—	6.0	V	—
Voltage Regulator – 3.3V						
Output Voltage	V_{REG}	3.20	3.30	3.40	V	0 mA < I_{OUT} < 70 mA
Line Regulation	$\Delta V_{OUT}1$	—	10	50	mV	I_{OUT} = 1 mA 6.0V < V_{BB} < 18V
Load Regulation	$\Delta V_{OUT}2$	—	10	50	mV	5 mA < I_{OUT} < 70 mA 6.0V < V_{BB} < 12V
Power Supply Ripple Reject	PSRR	—	50	—	dB	1 V_{PP} @ 10-20 kHz I_{LOAD} = 20 mA
Output Noise Voltage	eN	—	—	100	µV_{RMS} /$\sqrt{Hz}$	10 Hz – 40 MHz C_{FILTER} = 10 µF C_{BP} = 0.1 µF I_{LOAD} = 20 mA
Shutdown Voltage	V_{SD}	2.5	—	2.7	V	See Figure 1-5 (**Note 2**)
Input Voltage to Turn-Off Output	V_{OFF}	3.9	—	4.5	V	—
Input Voltage to Turn-On Output	V_{ON}	5.25	—	6	V	—

Note 1: Internal current limited. 2.0 ms maximum recovery time (R_{LBUS} = 0Ω, TX = 0, V_{LBUS} = V_{BB}).

2: Characterized, not 100% tested.

3: In Power-Down mode, normal LIN recessive/dominant threshold is disabled; $V_{WK(LBUS)}$ is used to detect bus activities.

FIGURE 2-1: ESR CURVES FOR LOAD CAPACITOR SELECTION



Note 1: The graph shows the minimum required capacitance after derating due to tolerance, temperature and voltage.

2.4 AC Specifications

AC Characteristics	Electrical Characteristics: Unless otherwise indicated, all limits are specified for V_{BB} = 6.0V to 18.0V; T_A = -40°C to +125°C.					
Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Bus Interface – Constant Slope Time Parameters						
Slope Rising and Falling Edges	t_{SLOPE}	3.5	—	22.5	µs	7.3V ≤ V_{BB} ≤ 18V
Propagation Delay of Transmitter	$t_{TRANSPD}$	—	—	6.0	µs	$t_{TRANSPD}$ = max. ($t_{TRANSPDR}$ or $t_{TRANSPDF}$)
Propagation Delay of Receiver	t_{RECPD}	—	—	6.0	µs	t_{RECPD} = max. (t_{RECPDR} or t_{RECPDF})
Symmetry of Propagation Delay of Receiver Rising Edge w.r.t. Falling Edge	t_{RECSYM}	-2.0	—	2.0	µs	t_{RECSYM} = max. (t_{RECPDF} – t_{RECPDR}) R_{RXD} = 2.4 kΩ to V_{CC} C_{RXD} = 20 pF
Symmetry of Propagation Delay of Transmitter Rising Edge w.r.t. Falling Edge	$t_{TRANSSYM}$	-2.0	—	2.0	µs	$t_{TRANSSYM}$ = max. ($t_{TRANSPDF}$ – $t_{TRANSPDR}$)
Bus Dominant Time-Out Time	$t_{TO(LIN)}$	—	25	—	mS	—
Duty Cycle 1 @ 20.0 kbps	—	0.396	—	—	%t_{BIT}	C_{BUS}; R_{BUS} conditions: 1 nF; 1 kΩ | 6.8 nF; 660Ω | 10 nF; 500Ω $TH_{REC(MAX)}$ = 0.744 x V_{BB}, $TH_{DOM(MAX)}$ = 0.581 x V_{BB}, V_{BB} = 7.0V – 18V; t_{BIT} = 50 µs. D1 = $t_{BUS\_REC(MIN)}$/2 x t_{BIT}
Duty Cycle 2 @ 20.0 kbps	—	—	—	0.581	%t_{BIT}	C_{BUS}; R_{BUS} conditions: 1 nF; 1 kΩ | 6.8 nF; 660Ω | 10 nF; 500Ω $TH_{REC(MAX)}$ = 0.284 x V_{BB}, $TH_{DOM(MAX)}$ = 0.422 x V_{BB}, V_{BB} = 7.6V – 18V; t_{BIT} = 50 µs. D2 = $t_{BUS\_REC(MAX)}$/2 x t_{BIT}
Duty Cycle 3 @ 10.4 kbps	—	0.417	—	—	%t_{BIT}	C_{BUS}; R_{BUS} conditions: 1 nF; 1 kΩ | 6.8 nF; 660Ω | 10 nF; 500Ω $TH_{REC(MAX)}$ = 0.778 x V_{BB}, $TH_{DOM(MAX)}$ = 0.616 x V_{BB}, V_{BB} = 7.0V – 18V; t_{BIT} = 96 µs. D3 = $t_{BUS\_REC(MIN)}$/2 x t_{BIT}
Duty Cycle 4 @ 10.4 kbps	—	—	—	0.590	%t_{BIT}	C_{BUS}; R_{BUS} conditions: 1 nF; 1 kΩ | 6.8 nF; 660Ω | 10 nF; 500Ω $TH_{REC(MAX)}$ = 0.251 x V_{BB}, $TH_{DOM(MAX)}$ = 0.389 x V_{BB}, V_{BB} = 7.6V – 18V; t_{BIT} = 96 µs. D4 = $t_{BUS\_REC(MAX)}$/2 x t_{BIT}

Note 1: Time depends on external capacitance and load. Test condition: C_{REG} = 4.7 µF, no resistor load.

2: Characterized, not 100% tested.

2.4 AC Specifications (Continued)

AC Characteristics	Electrical Characteristics: Unless otherwise indicated, all limits are specified for V_{BB} = 6.0V to 18.0V; T_A = -40°C to +125°C.					
Parameter	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Voltage Regulator						
Bus Activity Debounce Time	t_{BDB}	30	80	250	µs	—
Bus Activity to Voltage Regulator Enabled	$t_{BACTIVE}$	35	—	200	µs	—
Voltage Regulator Enabled to Ready	t_{VEVR}	300	—	1200	µs	**Note 1**
Chip Select to Ready Mode	t_{CSR}	—	—	230	µs	—
Chip Select to Power-Down	t_{CSPD}	—	—	300	µs	**Note 2**
Short Circuit to Shutdown	$t_{SHUTDOWN}$	20	—	100	µs	—
$\overline{\text{RESET}}$ Timing						
V_{REG} OK Detect to $\overline{\text{RESET}}$ Inactive	t_{RPU}	—	—	60.0	µs	**Note 2**
V_{REG} Not OK Detect to $\overline{\text{RESET}}$ Active	t_{RPD}	—	—	60.0	µs	**Note 2**

Note 1: Time depends on external capacitance and load. Test condition: C_{REG} = 4.7 µF, no resistor load.

2: Characterized, not 100% tested.

2.5 Thermal Specifications

Parameter	Sym.	Min.	Typ.	Max.	Units	Test Conditions
Specified Temperature Range	T_A	-40	—	+125	°C	—
Maximum Junction Temperature	T_J	—	—	+150	°C	—
Storage Temperature Range	T_A	-65	—	+150	°C	—
Recovery Temperature	$\theta_{RECOVERY}$	—	+140	—	°C	—
Shutdown Temperature	$\theta_{SHUTDOWN}$	—	+150	—	°C	—
Short Circuit Recovery Time	t_{THERM}	—	1.5	5.0	ms	—
Thermal Package Resistances						
Thermal Resistance, 8-PDIP	θ_{JA}	—	89.3	—	°C/W	—
Thermal Resistance, 8-SOIC	θ_{JA}	—	149.5	—	°C/W	—
Thermal Resistance, 8L-DFN	θ_{JA}	—	48.0	—	°C/W	—

Note 1: The maximum power dissipation is a function of T_{JMAX}, θ_{JA} and ambient temperature, T_A. The maximum allowable power dissipation at an ambient temperature is $P_D = (T_{JMAX} – T_A)\ \theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the MCP2025 will go into thermal shutdown.

2.6 Typical Performance Curves

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

Note: Unless otherwise indicated, V_{BB} = 6.0V to 18.0V; T_A = -40°C to +125°C.

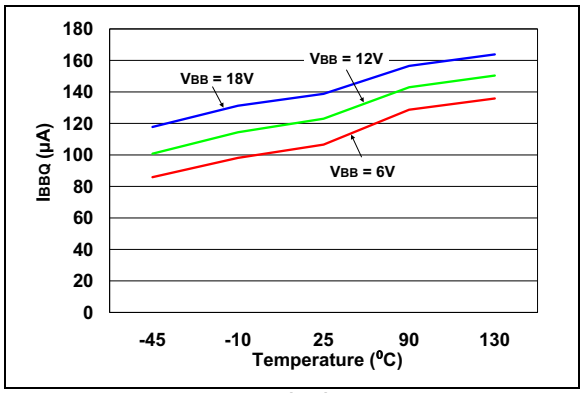


FIGURE 2-2: *Typical I_{BBQ} vs. Temperature – 5.0V.*

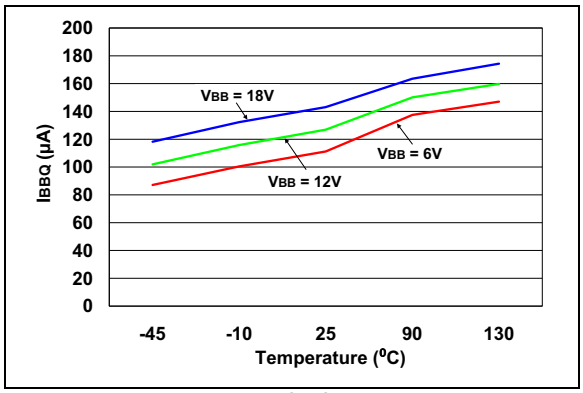


FIGURE 2-5: *Typical I_{BBQ} vs. Temperature – 3.3V.*

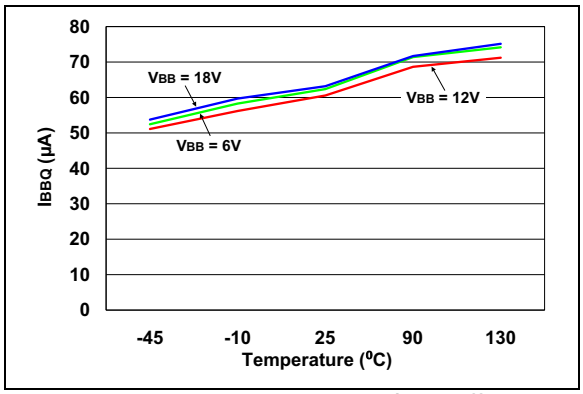


FIGURE 2-3: *I_{BBQ} Transmitter-Off vs. Temperature – 5.0V.*

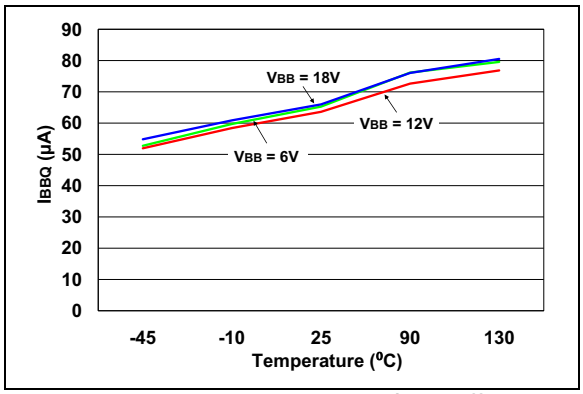


FIGURE 2-6: *I_{BBQ} Transmitter-Off vs. Temperature – 3.3V.*

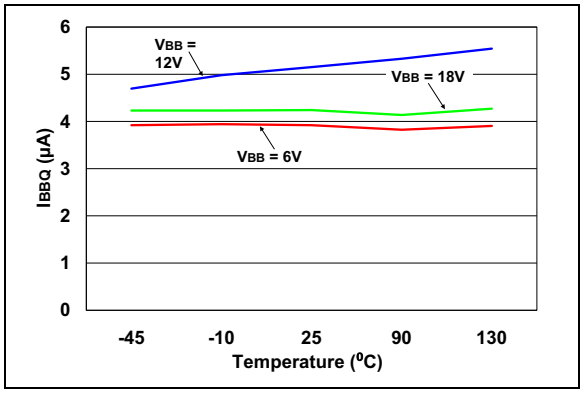


FIGURE 2-4: *I_{BBQ} Power-Down vs. Temperature – 5.0V.*

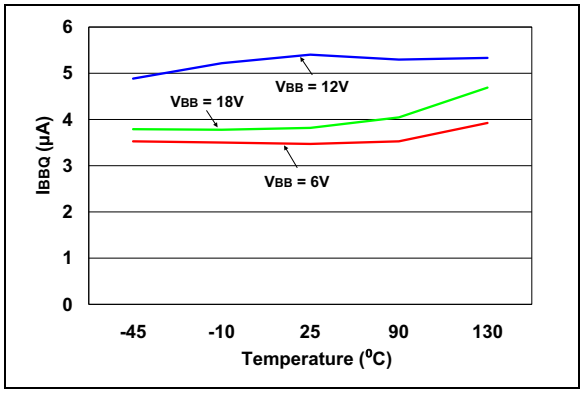


FIGURE 2-7: *I_{BBQ} Power-Down vs. Temperature – 3.3V.*

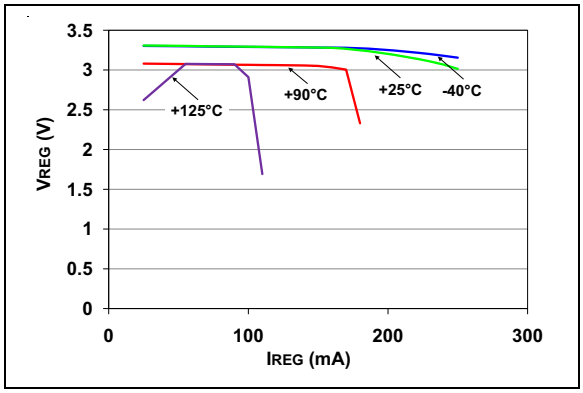


FIGURE 2-8: *5.0V V_{REG} vs. I_{REG} at V_{BB} = 12V.*

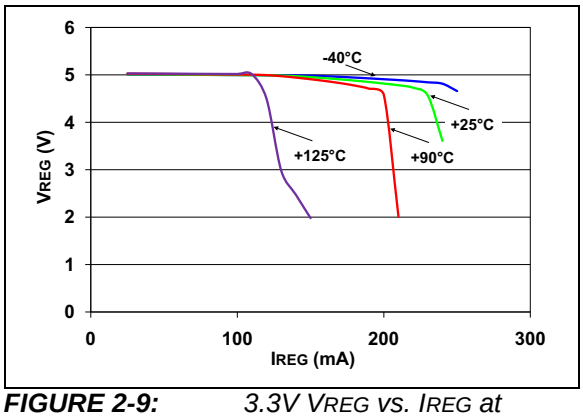


FIGURE 2-9: *3.3V V_{REG} vs. I_{REG} at V_{BB} = 12V.*

2.7 Timing Diagrams and Specifications

FIGURE 2-10: BUS TIMING DIAGRAM

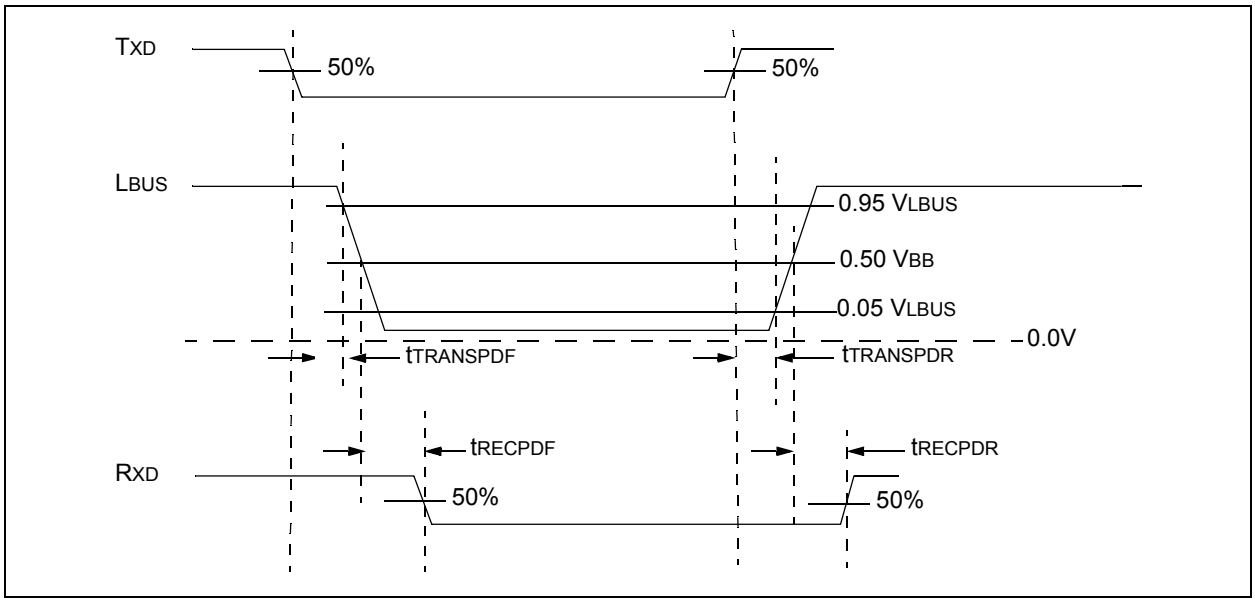


FIGURE 2-11: REGULATOR BUS WAKE TIMING DIAGRAM

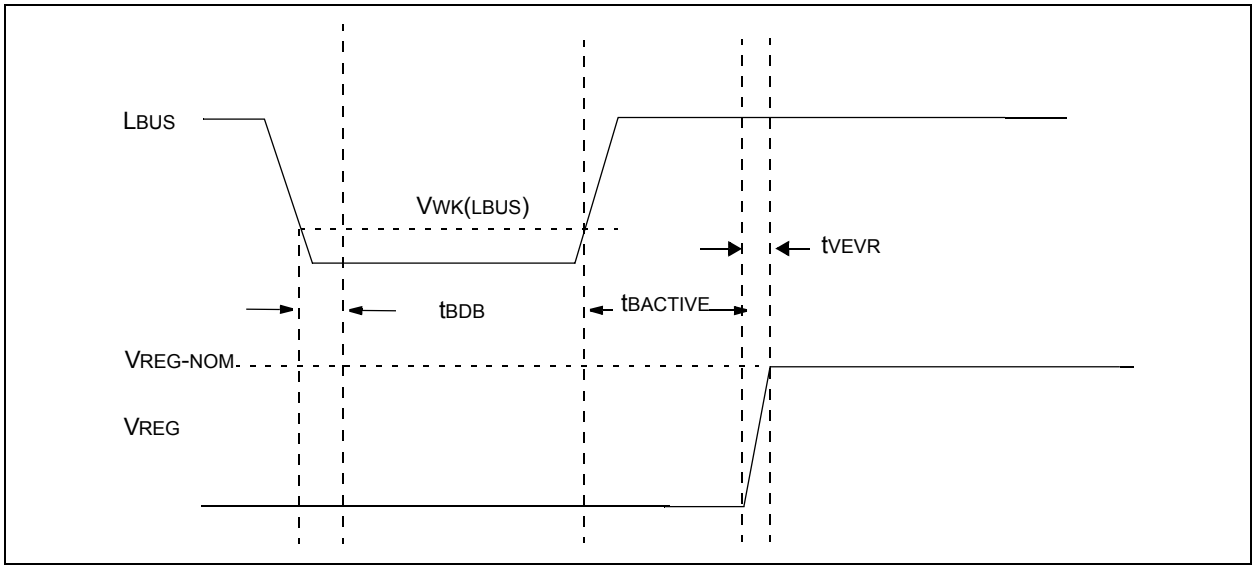
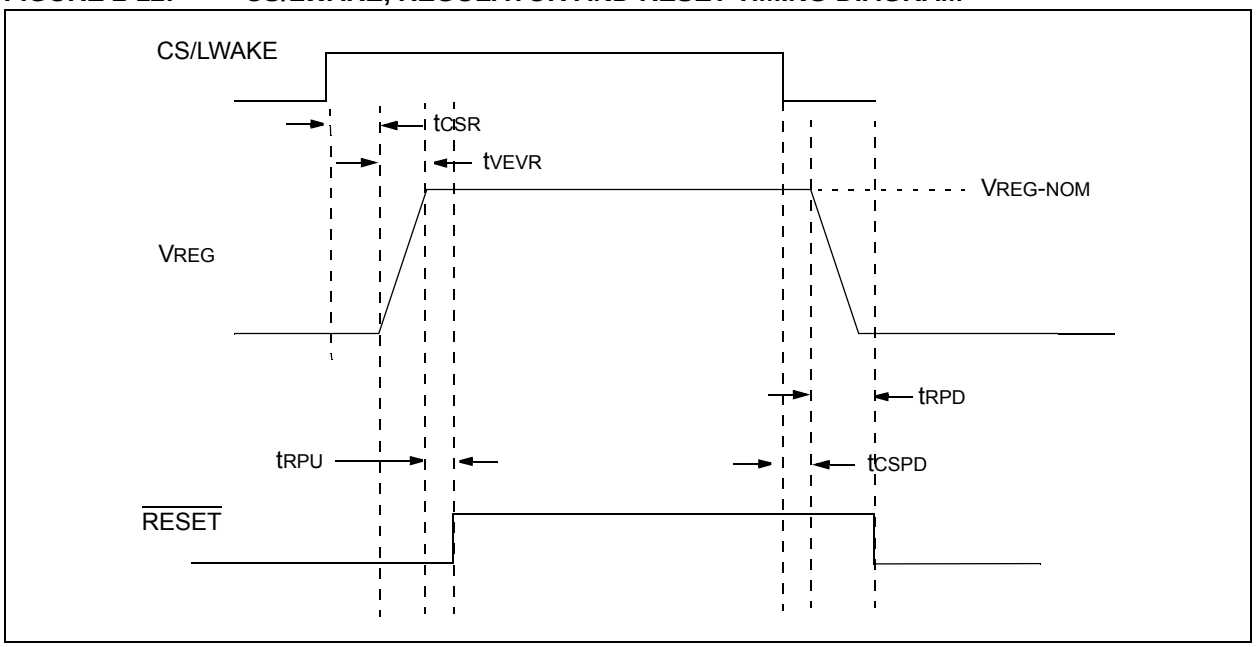


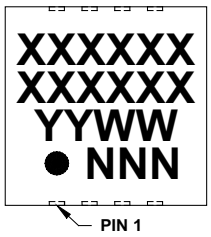
FIGURE 2-12: CS/LWAKE, REGULATOR AND $\overline{\text{RESET}}$ TIMING DIAGRAM



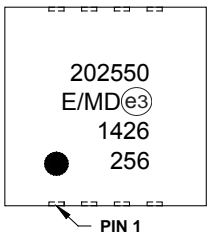
3.0 PACKAGING INFORMATION

3.1 Package Marking Information

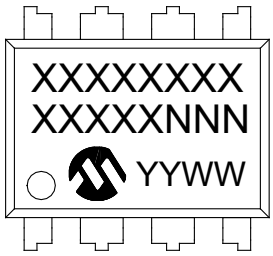
8-Lead DFN (4x4x0.9 mm)



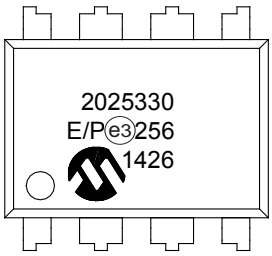
Example



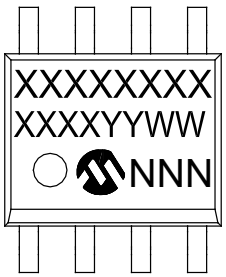
8-Lead PDIP (300 mil)



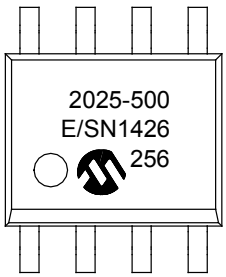
Example



8-Lead SOIC (3.90 mm)



Example

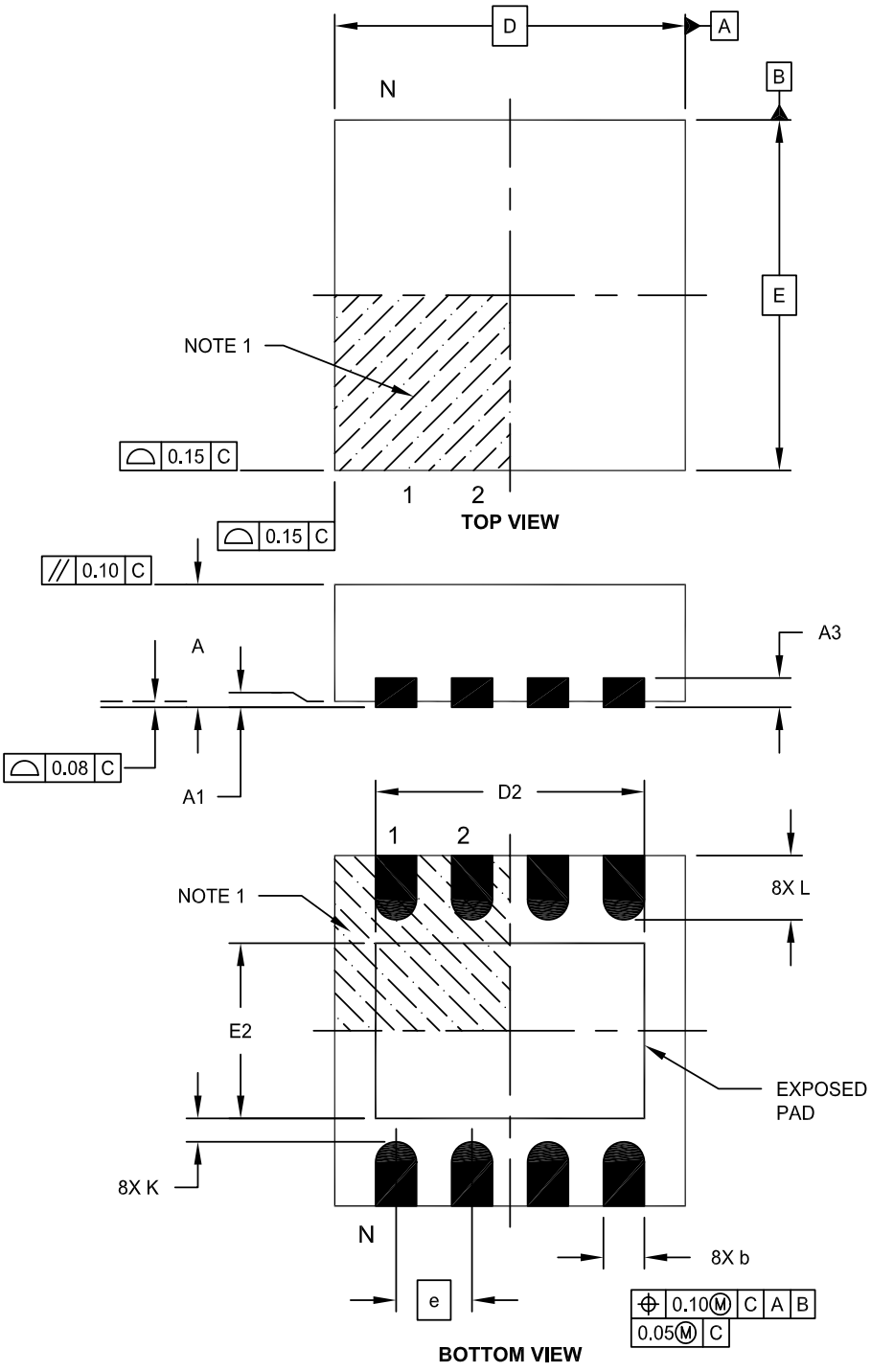


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

8-Lead Plastic Dual Flat, No Lead Package (MD) – 4x4x0.9 mm Body [DFN]

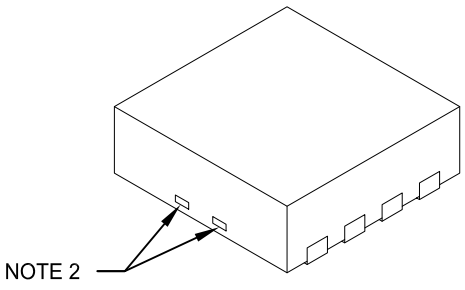
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-131E Sheet 1 of 2

8-Lead Plastic Dual Flat, No Lead Package (MD) – 4x4x0.9 mm Body [DFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.80 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.20 REF	
Overall Length	D		4.00 BSC	
Exposed Pad Width	E2	2.60	2.70	2.80
Overall Width	E		4.00 BSC	
Exposed Pad Length	D2	3.40	3.50	3.60
Contact Width	b	0.25	0.30	0.35
Contact Length	L	0.30	0.40	0.50
Contact-to-Exposed Pad	K	0.20	-	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package may have one or more exposed tie bars at ends.
3. Package is saw singulated
4. Dimensioning and tolerancing per ASME Y14.5M

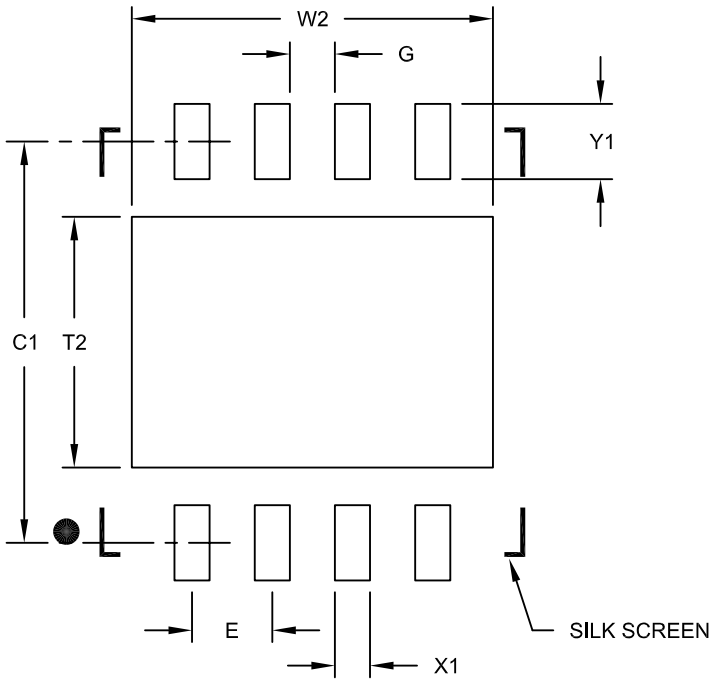
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-131E Sheet 2 of 2

8-Lead Plastic Dual Flat, No Lead Package (MD) - 4x4x0.9 mm Body [DFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.80 BSC		
Optional Center Pad Width	W2			3.60
Optional Center Pad Length	T2			2.50
Contact Pad Spacing	C1		4.00	
Contact Pad Width (X8)	X1			0.35
Contact Pad Length (X8)	Y1			0.75
Distance Between Pads	G	0.45		

Notes:

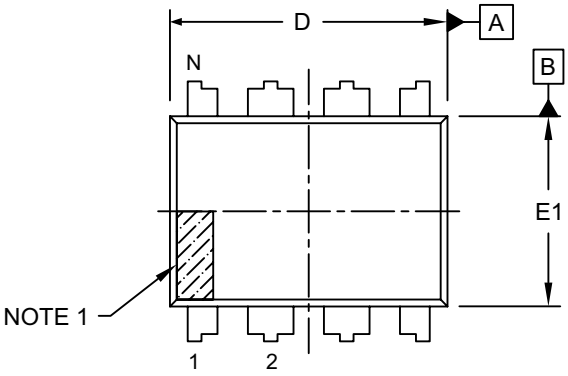
1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

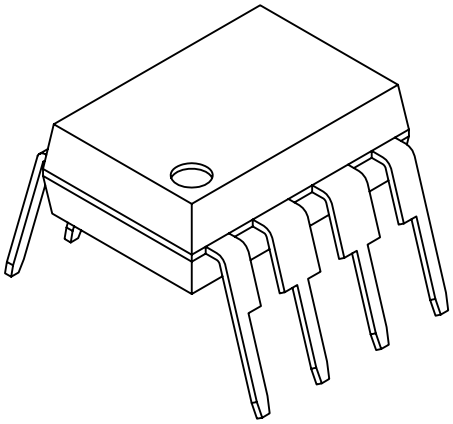
Microchip Technology Drawing No. C04-2131C

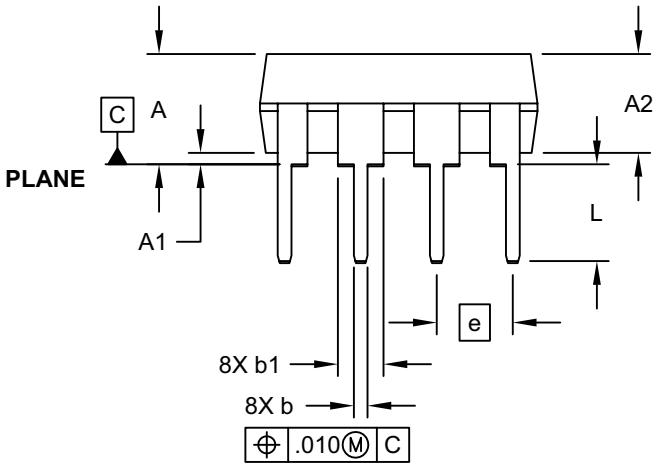
8-Lead Plastic Dual In-Line (P) - 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

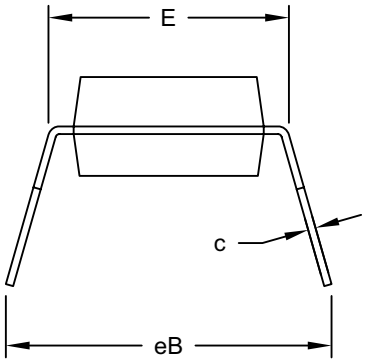


TOP VIEW





SIDE VIEW

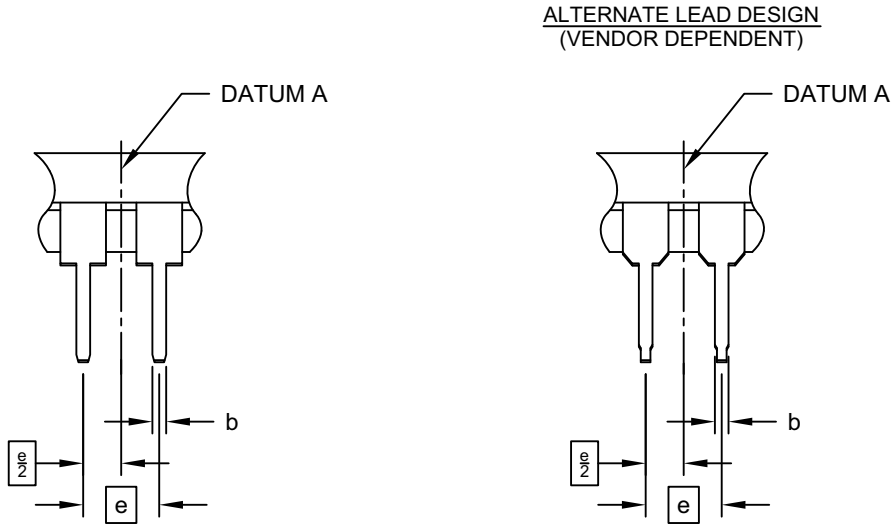


END VIEW

Microchip Technology Drawing No. C04-018D Sheet 1 of 2

8-Lead Plastic Dual In-Line (P) - 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		.100 BSC	
Top to Seating Plane	A	-	-	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	-	-
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.348	.365	.400
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.040	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	-	-	.430

Notes:

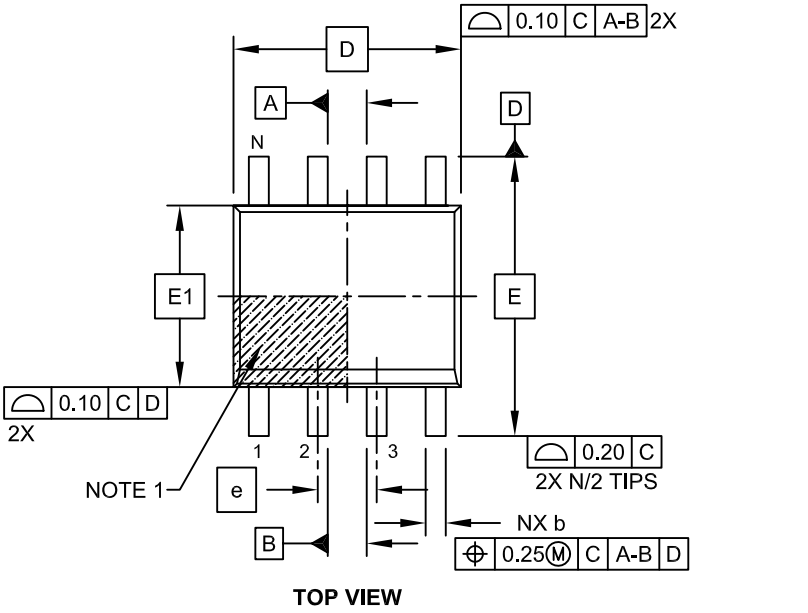
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

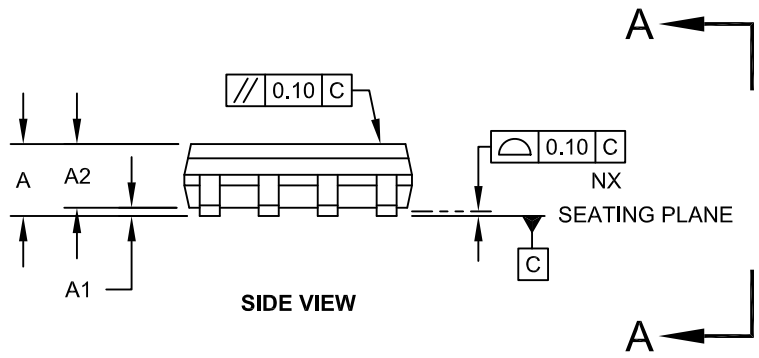
Microchip Technology Drawing No. C04-018D Sheet 2 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm Body [SOIC]

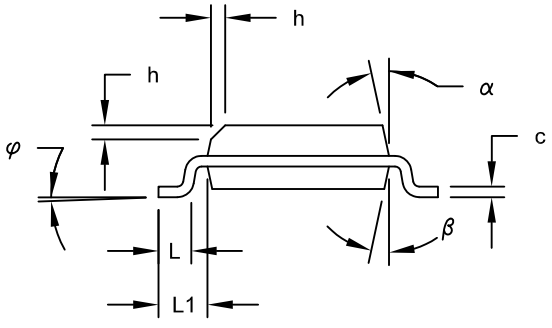
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW

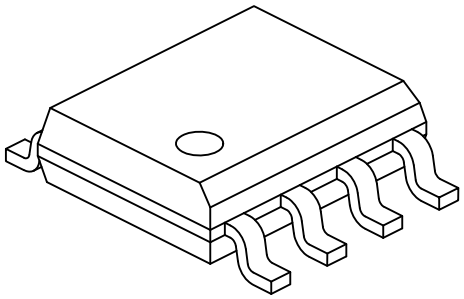


VIEW A-A

Microchip Technology Drawing No. C04-057C Sheet 1 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	-	-	1.75
Molded Package Thickness	A2	1.25	-	-
Standoff §	A1	0.10	-	0.25
Overall Width	E		6.00 BSC	
Molded Package Width	E1		3.90 BSC	
Overall Length	D		4.90 BSC	
Chamfer (Optional)	h	0.25	-	0.50
Foot Length	L	0.40	-	1.27
Footprint	L1		1.04 REF	
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.17	-	0.25
Lead Width	b	0.31	-	0.51
Mold Draft Angle Top	α	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°

Notes:

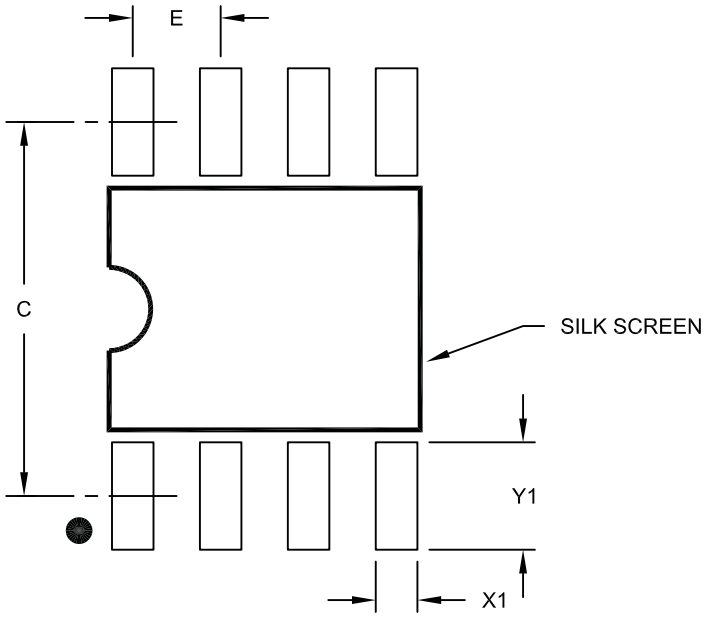
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing No. C04-057C Sheet 2 of 2

8-Lead Plastic Small Outline (SN) – Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		1.27 BSC	
Contact Pad Spacing	C		5.40	
Contact Pad Width (X8)	X1			0.60
Contact Pad Length (X8)	Y1			1.55

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2057A

NOTES:

APPENDIX A: REVISION HISTORY

Revision B (August 2014)

The following is the list of modifications:

1. Clarified CREG selection.
2. Updated **Section 1.6 "Typical Applications"** with values used during ESD tests.
3. Minor typographical corrections.

Revision A (June 2012)

- Original Release of this Document.

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	–X	X	/XX
Device	Voltage	Temperature Range	Package

Device:	MCP2025:	LIN Transceiver with Voltage Regulator
	MCP2025T:	LIN Transceiver with Voltage Regulator (Tape and Reel)
Voltage:	330 =	3.3V
	500 =	5.0V
Temperature Range:	E =	-40°C to +125°C
Package:	MD =	8LD Plastic Dual Flat, No Lead – 4x4x0.8 mm Body
	P =	8LD/14LD Plastic Dual In-Line – 300 mil Body
	SN =	8LD Plastic Small Outline – Narrow, 3.90 mm Body

Examples:

a)	MCP2025-330E/MD:	3.3V, 8-lead DFN package
b)	MCP2025-500E/MD:	5.0V, 8-lead DFN package
c)	MCP2025T-330E/MD:	3.3V, 8-lead DFN package, Tape and Reel
d)	MCP2025T-500E/MD:	5.0V, 8-lead DFN package, Tape and Reel
e)	MCP2025-330E/P:	3.3V, 8-lead PDIP package
f)	MCP2025-500E/P:	5.0V, 8-lead PDIP package
g)	MCP2025-330E/SN:	3.3V, 8-lead SOIC package
h)	MCP2025-500E/SN:	5.0V, 8-lead SOIC package
i)	MCP2025T-330E/SN:	3.3V, 8-lead SOIC package, Tape and Reel
j)	MCP2025T-500E/SN:	5.0V, 8-lead SOIC package, Tape and Reel

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