ISL6506A, ISL6506B

Multiple Linear Power Controller with ACPI Control Interface

FN9141
Rev.8.00
Aug 8, 2019

The ISL6506A and ISL6506B complement other power building blocks (voltage regulators) in ACPI-compliant designs for microprocessor and computer applications. They integrate the control of the $5V_{DUAL}$ and $3.3V_{DUAL}$ rails into an 8 Ld EPAD SOIC package. The ISL6506A and ISL6506B's operating mode (active outputs or sleep outputs) is selectable through two digital control pins; $\overline{S3}$ and $\overline{S5}$.

A completely integrated linear regulator generates the $3.3V_{DUAL}$ voltage plane from the ATX supply's $5V_{SB}$ output during sleep states (S3, S4/S5). In active states (during S0 and S1/S2), the ISL6506A and ISL6506B use an external N-Channel pass MOSFET to connect the outputs directly to the 3.3V input supplied by an ATX power supply, for minimal losses.

The ISL6506A and ISL6506B power up the $5V_{DUAL}$ plane by switching in the ATX 5V output through an NMOS transistor in active states, or by switching in the ATX $5V_{SB}$ through a PMOS (or PNP) transistor in S3 sleep state. In S4/S5 sleep states, the ISL6506B $5V_{DUAL}$ output is shut down. In the ISL6506A, the $5V_{DUAL}$ output stays on during S4/S5 sleep states.

The ISL6506A and ISL6506B are functionally identical, except for the sleep mode in the preceding paragraph. In addition, the ISL6506A has a 1A current limit on the internal 3.3V LDO; the ISL6506B has a 2A current limit.

Related Literature

For a full list of related documents, visit our website:

- ISL6506A, ISL6506B

Features

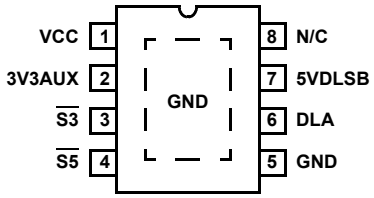
- Provides 2 ACPI-Controlled Voltages
  - $5V_{DUAL}$ USB/Keyboard/Mouse
  - $3.3V_{DUAL}/3.3V_{SB}$ PCI/Auxiliary/LAN
- Excellent $3.3V_{DUAL}$ Regulation in S3/S4/S5
  - ±2.0% Over-Temperature
  - 1A Capability on ISL6506A
  - 2A Capability on ISL6506B
- Small Size; Very Low External Component Count
- Over-Temperature Shutdown
- Pb-Free Available (RoHS Compliant)

Applications

- ACPI-Compliant Power Regulation for Motherboards
  - ISL6506B: $5V_{DUAL}$ is shut down in S4/S5 sleep states
  - ISL6506A: $5V_{DUAL}$ stays on in S4/S5 sleep states

Pinout

8 LD EPSOIC
TOP VIEW



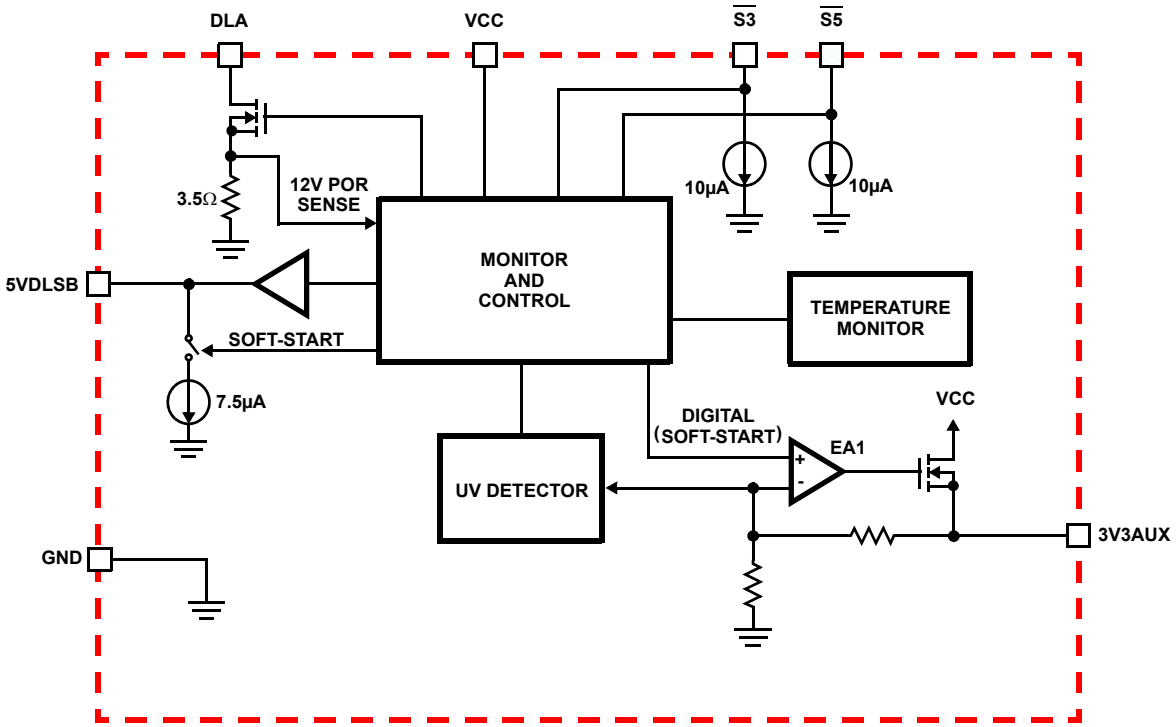
Ordering Information

PART NUMBER (Notes 2, 3)	PART MARKING	TEMP. RANGE (°C)	TAPE AND REEL (Units) (Note 1)	PACKAGE (RoHS Compliant)	PKG. DWG. #
ISL6506ACBZ	6506 ACBZ	0 to +70	-	8 Ld EPSOIC	M8.15C
ISL6506ACBZ-T	6506 ACBZ	0 to +70	2.5k	8 Ld EPSOIC	M8.15C
ISL6506BCBZ	6506 BCBZ	0 to +70	-	8 Ld EPSOIC	M8.15C
ISL6506BCBZ-T	6506 BCBZ	0 to +70	2.5k	8 Ld EPSOIC	M8.15C
ISL6506BCBZA	6506 BCBZ	0 to +70	-	8 Ld EPSOIC	M8.15C
ISL6506BCBZA-T	6506 BCBZ	0 to +70	2.5k	8 Ld EPSOIC	M8.15C

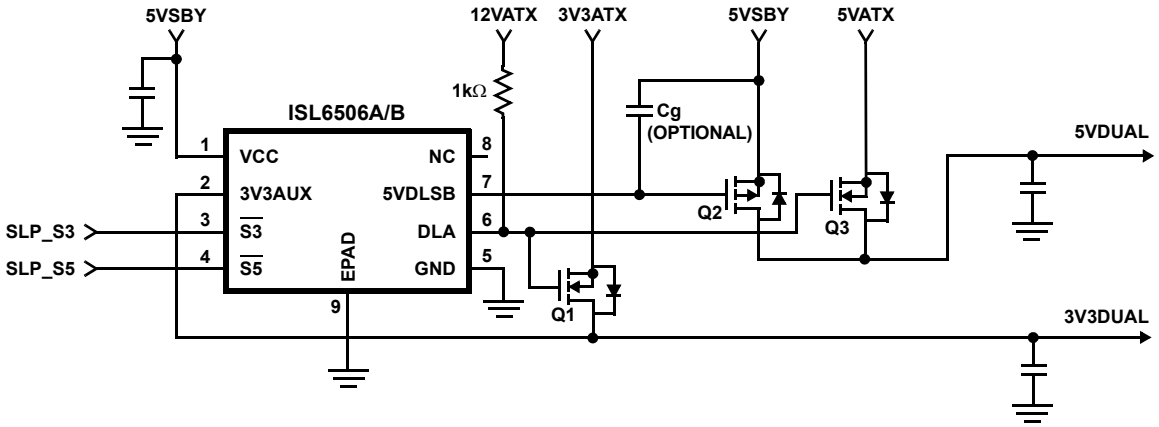
NOTES:

1. See TB347 for details about reel specifications.
2. These Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J-STD-020.
3. For Moisture Sensitivity Level (MSL), see the ISL6506A, ISL6506B device pages. For more information about MSL, see TB363.

Block Diagram



Typical Application



Absolute Maximum Ratings

Supply Voltage, V_{5VSB} . . . . . +7.0V
DLA . . . . . GND - 0.3V to +14.5V
All Other Pins . . . . . +7.0V
ESD Rating
Human Body Model 4000V

Thermal Information

Thermal Resistance (Typical)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
EPSOIC Package (Notes 4, 5)	40	3.5

Maximum Junction Temperature (Plastic Package) . . . . . +150°C
Maximum Storage Temperature Range . . . . . -65°C to +150°C
Pb-Free Reflow Profile. . . . . see TB493

Recommended Operating Conditions

Supply Voltage, V_{5VSB} . . . . . +5V ±5%
Lowest 5VSB Supply Voltage Guaranteeing Parameters . . . . +4.5V
Digital Inputs, $V_{\overline{Sx}}$ . . . . . 0V to +5.5V
Ambient Temperature Range . . . . . 0°C to +70°C
Junction Temperature Range . . . . . 0°C to +125°C

CAUTION: *Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions can adversely impact product reliability and result in failures not covered by warranty.*

NOTES:

4. θ_{JA} is measured in free air with the component mounted on a high-effective thermal conductivity test board with “direct attach” features.
5. For θ_{JC}, the “case temp” location is the center of the exposed metal pad on the package underside.

Electrical Specifications

Recommended Operating Conditions. **Boldface limits apply over the operating temperature range, 0°C to +70°C.**

PARAMETER	SYMBOL	TEST CONDITIONS	MIN (Note 6)	TYP	MAX (Note 6)	UNIT
VCC SUPPLY CURRENT						
Nominal Supply Current	I_{5VSB}	$V_{\overline{S3}}$ = 5V, $V_{\overline{S5}}$ = 5V (S0 State)	-	3.60	-	mA
		$V_{\overline{S3}}$ = 0V, $V_{\overline{S5}}$ = 5V (S3 State)	-	4.60	-	mA
		$V_{\overline{S5}}$ = 0V (S5 State)	-	4.60	-	mA
POWER-ON RESET						
Rising 5VSB POR Threshold			-	-	**4.5**	V
Falling 5VSB POR Threshold			**3.60**	-	**3.95**	V
Rising 12V POR Threshold		1.00kΩ resistor between DLA and 12V Rail	**8.9**	9.8	**10.8**	V
3.3V_{AUX} LINEAR REGULATOR						
Regulation		V_{5VSBY} = 5.0V, I_{3V3SB} = 0A	-	-	**2.0**	%
3V3SB Nominal Voltage Level	V_{3V3SB}		-	3.3	-	V
3V3SB Undervoltage Threshold	V_{3V3SB_UV}		-	2.475	-	V
3V3SB Overcurrent Trip	I_{3V3SB_TRIP}	ISL6506A	-	-	**1**	A
		ISL6506B	-	-	**2**	A
5V_{DUAL} SWITCH CONTROLLER						
5VDLSB Output Drive Current	I_{5VDLSB}	V_{5VDLSB} = 4V, V_{5VSB} = 5V	**20**	-	**35**	mA
TIMING INTERVAL						
S0 to S3 Transition Delay			-	58	-	µs
SOFT-START						
Soft-start Interval	t_{SS}		**6.55**	8.2	**9.85**	ms
5VDLSB Soft-start Current Source			-	-7.5	-	µA
CONTROL I/O ($\overline{S3}$, $\overline{S5}$)						
High Level Input Threshold			-	-	**2.2**	V
Low Level Input Threshold			**0.8**	-	-	V
$\overline{S3}$, $\overline{S5}$ Internal Pull-down Current to GND			-	10	-	µA
TEMPERATURE MONITOR						
Shutdown-Level Threshold			-	140	-	°C

NOTE:

6. Compliance to datasheet limits is assured by one or more methods: production test, characterization, and/or design.

Functional Pin Description

VCC (Pin 1)

Provide a very well decoupled 5V bias supply for the IC to this pin by connecting it to the ATX $5V_{SB}$ output. This pin provides all the bias for the IC as well as the input voltage for the internal standby 3V3AUX LDO. The voltage at this pin is monitored for power-on reset (POR) purposes.

GND (Pin 5, Pad)

Signal ground for the IC. These pins are also the ground return for the internal 3V3AUX LDO that is active in S3/S4/S5 sleep states. All voltage levels are measured with respect to these pins.

$\overline{S3}$ and $\overline{S5}$ (Pins 3 and 4)

These pins switch the IC's operating state from active (S0, S1/S2) to S3 and S4/S5 sleep states. These are digital inputs featuring internal 10µA pull-down current sources on each pin. Additional circuitry blocks illegal state transitions, such as S4/S5 to S3. Connect $\overline{S3}$ and $\overline{S5}$ to the computer system's $\overline{SLP_S3}$ and $\overline{SLP_S5}$ signals, respectively.

3V3AUX (Pin 2)

Connect this pin to the 3V3DUAL output. In sleep states, the voltage at this pin is regulated to 3.3V through an internal pass device powered from 5VSBY through the VCC pin. In active states, ATX 3.3V output is delivered to this node through a fully-on NMOS transistor. During S3 and S4/S5 states, this pin is monitored for undervoltage events.

DLA (Pin 6)

This pin is an open-drain output. A 1kΩ resistor must be connected from this pin to the ATX 12V output. This resistor is used to pull the gates of suitable N-MOSFETs to 12V, which in active state, switch in the ATX 3.3V and 5V outputs into the $3.3V_{AUX}$ and $5V_{DUAL}$ outputs, respectively. This pin is also used to monitor the 12V rail during POR. If a resistor other than 1kΩ is used, the POR level will be affected.

5VDLSB (Pin 7)

Connect this pin to the gate of a suitable P-MOSFET.

ISL6506B: In S3 sleep state, this transistor is switched on, connecting the ATX $5V_{SB}$ output to the $5V_{DUAL}$ regulator output.

ISL6506A: In S3 and S4/S5 sleep state, this transistor is switched on, connecting the ATX $5V_{SB}$ output to the $5V_{DUAL}$ regulator output.

Description

Operation

The ISL6506A and ISL6506B control two output voltages, $3.3V_{DUAL}$ and $5V_{DUAL}$. They are designed for microprocessor computer applications requiring 3.3V, 5V, $5V_{SB}$, and 12V bias input from an ATX power supply. The ICs are composed of one linear controller/regulator supplying the computer system's $3.3V_{DUAL}$ power, a dual switch controller supplying the $5V_{DUAL}$ voltage, and all the control and monitoring functions necessary for complete ACPI implementation.

Initialization

The ISL6506A and ISL6506B automatically initialize on receipt of input power. The Power-On Reset (POR) function continually monitors the $5V_{SB}$ input supply voltage. The ISL6506A and ISL6506B also monitor the 12V rail to ensure that the ATX rails are up before entering into the S0 state even if both $\overline{SLP_S3}$ and $\overline{SLP_S5}$ are both high.

Dual Outputs Operational Truth Table

Table 1 describes the truth combinations pertaining to the $3.3V_{DUAL}$ and $5V_{DUAL}$ outputs. The internal circuitry does not allow the transition from an S4/S5 state to an S3 state.

TABLE 1. $5V_{DUAL}$ OUTPUT TRUTH TABLE

$\overline{S5}$	$\overline{S3}$	3.3AUX	5VDL	COMMENTS
1	1	3.3V	5V	S0/S1/S2 States (Active)
1	0	3.3V	5V	S3
0	1	Note		Maintains Previous State
0	0	3.3V	0V	S4/S5 (ISL6506B)
0	0	3.3V	5V	S4/S5 (ISL6506A)

NOTE: Combination Not Allowed.

Functional Timing Diagrams

Figures 1 (ISL6506B) and 2 (ISL6506A) are simplified timing diagrams, detailing the power-up/down sequences of all the outputs in response to the status of the sleep-state pins ($\overline{S3}$, $\overline{S5}$), as well as the status of the input ATX supply. Not shown in these diagrams is the deglitching feature used to protect against false sleep state tripping. Additionally, the ISL6506A and ISL6506B feature a 60µs delay in transitioning from S0 to S3 states. The transition from the S0 state to S4/S5 state is immediate.

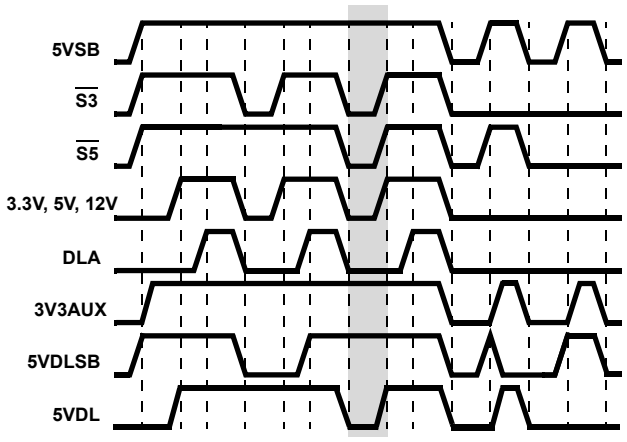


FIGURE 1. $5V_{DUAL}$ AND $3.3V_{AUX}$ TIMING DIAGRAM; ISL6506B

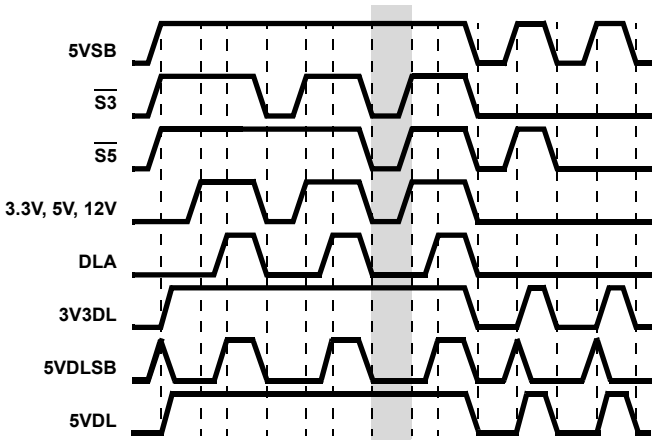


FIGURE 2. $5V_{DUAL}$ AND $3.3V_{AUX}$ TIMING DIAGRAM; ISL6506A

Soft-Start

Figures 3 and 4 show the soft-start sequence for the typical application start-up into a sleep state. At time t0, $5V_{SB}$ (bias) is applied to the circuit. At time t1, the $5V_{SB}$ surpasses POR level. Time t2, one soft-start interval after t1, denotes the initiation of soft-start. The $3.3V_{DUAL}$ rail is brought up through the internal standby LDO through an internal digital soft-start function. Figure 4 shows the $5V_{DUAL}$ rail initiating a soft-start at time t2 as well. The ISL6506A draws 7.5µA into the 5VDLSB for a duration of one soft-start period. This current will enhance the P-MOSFET (Q_2, see "Typical Application" on page 2) in a controlled manner. At time t3, the $3.3V_{DUAL}$ is in regulation and the 5VDLSB pin is pulled down to ground. If the $5V_{DUAL}$ rail has not reached the level of the $5V_{SB}$ rail by time t3, then the rail will experience a sudden step as the P-MOSFET gate is fully enhanced. The soft-start profile of the $5V_{DUAL}$ may be altered by placing a capacitor between the gate and drain of the P-MOSFET. Adding this capacitor will increase the gate capacitance and slow down the start of the $5V_{DUAL}$ rail.

At time t4, the system has transitioned into S0 state and the ATX supplies have begun to ramp-up. With the ISL6506B (Figure 3), the $5V_{DUAL}$ rail will begin to ramp-up from the $5V_{ATX}$ rail through the body diode of the N-MOSFET (Q_3). The ISL6506A already has the $5V_{DUAL}$ rail in regulation (Figure 4). At time t5, the $12V_{ATX}$ rail has surpassed the 12V POR level. Time t6 is three soft-start cycles after the 12V POR level has been surpassed. At time t6, three events occur simultaneously. The DLA pin is forced to a high impedance state, which allows the 12V rail to enhance the two N-MOSFETs (Q_1 and Q_3) that connect the ATX rails to the $3.3V_{DUAL}$ and $5V_{DUAL}$ rails. The 5VDLSB pin is actively pulled high, which turns the P-MOSFET (Q_2) off. Finally, the internal LDO that regulates the $3.3V_{AUX}$ rail in sleep states is put in standby mode.

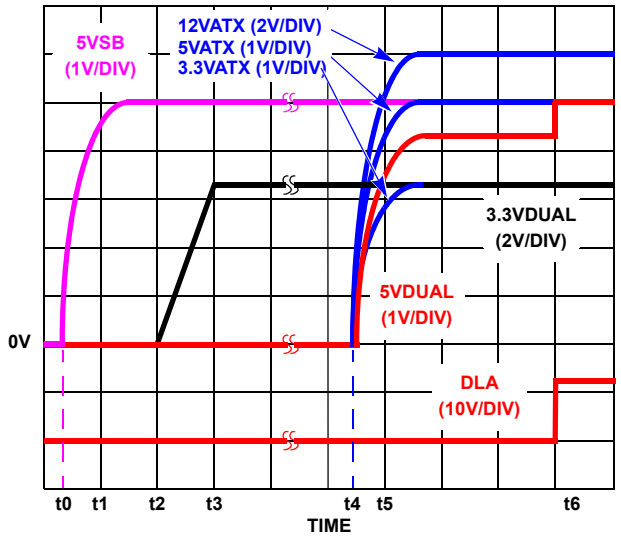


FIGURE 3. ISL6506B SOFT-START INTERVAL IN S4/S5 STATE AND S5 TO S0 TRANSITION

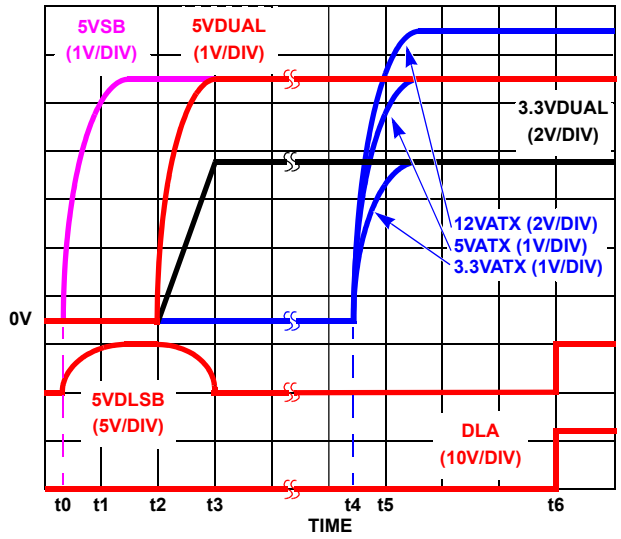


FIGURE 4. SOFT-START INTERVAL FOR ISL6506A IN S4/S5 AND S5 TO S0 TRANSITION FOR ISL6506A. ALSO S3 TO S0 TRANSITION FOR ISL6506A, ISL6506B

Sleep to Wake State Transitions

Figures 3 and 4, starting at time t4, depict the transitions from sleep states to the S0 wake state. Figure 3 shows the transition of the ISL6506B from the S4/S5 state to the S0 state. Figure 4 shows how the ISL6506B transitions from the S3 sleep state into S0 state. Figure 3 also shows how the ISL6506A transitions from either S3 or S4/S5 in the S0 state. For all transitions, t4 depicts the system transition into the S0 state. Here, the ATX supplies are enabled and begin to ramp up. At time t5, the $12V_{ATX}$ rail has exceeded the POR threshold for the ISL6506B and ISL6506A. Three soft-start periods after time t5, at time t6, three events occur simultaneously. The DLA pin is forced to a high impedance

state, which allows the 12V rail to enhance the two N-MOSFETs (Q_1 and Q_3) that connect the ATX rails to the $3.3V_{DUAL}$ and $5V_{DUAL}$ rails. The 5VDLSB pin is actively pulled high, which turns the P-MOSFET (Q_2) off. Finally, the internal LDO that regulates the $3.3V_{DUAL}$ rail in sleep states is put in standby mode.

Internal Linear Regulator Undervoltage Protection

The undervoltage protection on the internal linear regulator is only active during sleep states and after the initial soft-start ramp of the 3.3V linear regulator. The undervoltage trip point is set at 25% below nominal, or 2.475V.

When an undervoltage is detected, the 3.3V linear regulator is disabled. One soft-start interval later, the 3.3V linear regulator is retried with a soft-start ramp. If the linear regulator is retried 3 times and a fourth undervoltage is detected, the 3.3V linear regulator is disabled and can only be reset through a POR reset.

Internal Linear Regulator Overcurrent Protection

When an overcurrent condition is detected, the gate voltage to the internal NMOS pass element is reduced, which causes the output voltage of the linear regulator to be reduced. When the output voltage is reduced to the undervoltage trip point, the undervoltage protection is initiated and the output will shutdown.

Layout Considerations

The typical application employing the ISL6506A and ISL6506B is a fairly straight forward implementation. Like with any other linear regulator, attention has to be paid to the few potentially sensitive small signal components, such as those connected to sensitive nodes or those supplying critical bypass current.

The power components (pass transistors) and the controller IC should be placed first. Place the controller in a central position on the motherboard, not excessively far from the $3.3V_{DUAL}$ island or the I/O circuitry. Ensure the 3V3AUX connection is properly sized to carry 1A without exhibiting significant resistive losses at the load end. Similarly, the input bias supply ($5V_{SB}$) carries a similar level of current (for best results, ensure it is connected to its respective source through an adequately sized trace and is properly decoupled). Place the pass transistors on pads capable of heatsinking matching the device's power dissipation. As applicable, multiple via connections to a large internal plane can significantly lower localized device temperature rise.

Placement of the decoupling and bulk capacitors should reflect their purpose. As such, the high-frequency decoupling capacitors should be placed as close as possible to the load they are decoupling; the ones decoupling the controller close to the controller pins, the ones decoupling the load close to the load connector or the load itself (if embedded). Even though bulk capacitance (aluminum electrolytics or tantalum capacitors) placement is not as critical as the high-frequency capacitor placement, having these capacitors close to the load they serve is preferable.

Locate all small signal components close to the respective pins of the control IC, and connect them to ground, if applicable, through a via placed close to the ground pad.

A multi-layer printed circuit board is recommended. Figure 5 shows the connections to most of the components in the circuit. Note that the individual capacitors shown each could represent numerous physical capacitors. Dedicate one solid layer for a ground plane and make all critical component ground connections through vias placed as close to the component terminal as possible. The EPAD should be tied to the ground plane with three to five vias for good thermal management. Dedicate another solid layer as a power plane and break this plane into smaller islands of common voltage levels. Ideally, the power plane should support both the input power and output power nodes. Use copper filled polygons on the top and bottom circuit layers to create power islands connecting the filtering components (output capacitors) and the loads. Use the remaining printed circuit layers for small signal wiring.

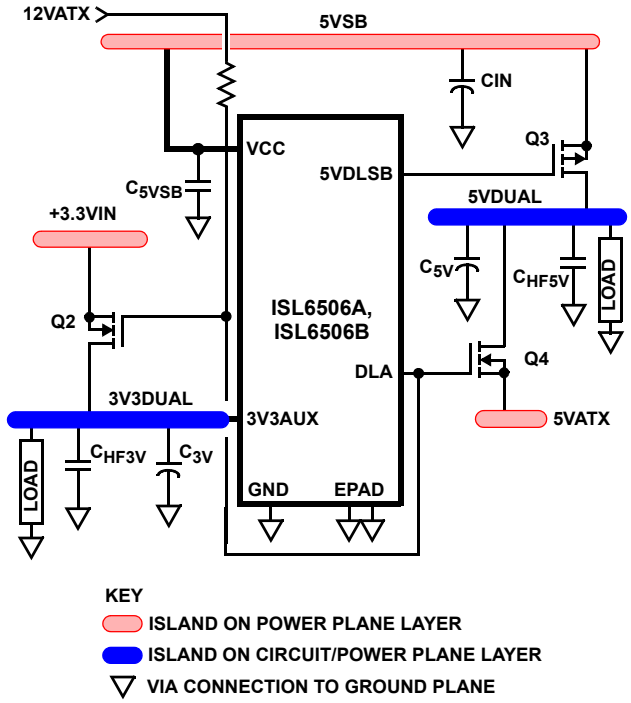


FIGURE 5. PRINTED CIRCUIT BOARD ISLANDS

Component Selection Guidelines

Output Capacitors Selection

The output capacitors should be selected to allow the output voltage to meet the dynamic regulation requirements of active state operation (S0/S1). The load transient for the various microprocessor system's components may require high quality capacitors to supply the high slew rate (di/dt)

current demands. Thus, it is recommended that the output capacitors be selected for transient load regulation, paying attention to their parasitic components (ESR, ESL).

Also, during the transition between active and sleep states on the $5V_{DUAL}$ output, there is a short interval of time during which none of the power pass elements are conducting. During this time the output capacitors have to supply all the output current. The output voltage drop during this brief period of time can be easily approximated using Equation 1:

$$\Delta V_{OUT} = I_{OUT} \times \left(ESR_{OUT} + \frac{t_t}{C_{OUT}} \right) \quad \text{(EQ. 1)}$$

where:

- ΔV_{OUT} = output voltage drop
- ESR_{OUT} = output capacitor bank ESR
- I_{OUT} = output current during transition
- C_{OUT} = output capacitor bank capacitance
- t_t = active-to-sleep/sleep-to-active transition time (10µs typical)

The output voltage drop is heavily dependent on the ESR (equivalent series resistance) of the output capacitor bank, the choice of capacitors should be such as to maintain the output voltage above the lowest allowable regulation level.

Input Capacitors Selection

The input capacitors for an ISL6506A and ISL6506B application must have a sufficiently low ESR so as not to allow the input voltage to dip excessively when energy is transferred to the output capacitors. If the ATX supply does not meet the specifications, certain imbalances between the ATX's outputs and the ISL6506, ISL6506A's regulation levels could have as a result a brisk transfer of energy from the input capacitors to the supplied outputs. At the transition between active and sleep states, such phenomena could be responsible for the $5V_{SB}$ voltage drooping excessively and affecting the output regulation. The solution to such a potential problem is using larger input capacitors with a lower total combined ESR.

Transistor Selection/Considerations

The ISL6506A and ISL6506B usually require one P-Channel and two N-Channel MOSFETs. All three of these MOSFETs are used as ON/OFF switching elements.

One important criteria for selection of transistors for all the switching elements is package selection for efficient removal of heat. The power dissipated in a switch element while on is shown in Equation 2:

$$P_{LOSS} = I_o^2 \times r_{DS(ON)} \quad \text{(EQ. 2)}$$

Select a package and heatsink that maintains the junction temperature below the rating with the maximum expected ambient temperature.

Q1, Q3

These N-Channel MOSFETs are used to switch the 3.3V and 5V inputs provided by the ATX supply into the $3.3V_{AUX}$ and $5V_{DUAL}$ outputs while in active (S0, S1) state. The main criteria for the selection of these transistors is output voltage budgeting. The maximum $r_{DS(ON)}$ allowed at highest junction temperature can be expressed using Equation 3:

$$r_{DS(ON)max} = \frac{V_{INmin} - V_{OUTmin}}{I_{OUTmax}} \quad \text{(EQ. 3)}$$

where:

- V_{INmin} = minimum input voltage
- V_{OUTmin} = minimum output voltage allowed
- I_{OUTmax} = maximum output current

Q2

This is a P-Channel MOSFET used to switch the $5V_{SB}$ output of the ATX supply into the $5V_{DUAL}$ output during sleep states. The selection criteria of this device, as with the N-Channel MOSFETs, is proper voltage budgeting. The maximum $r_{DS(ON)}$, however, has to be achieved with only 4.5V of gate-to-source voltage, so a true logic level MOSFET needs to be selected.

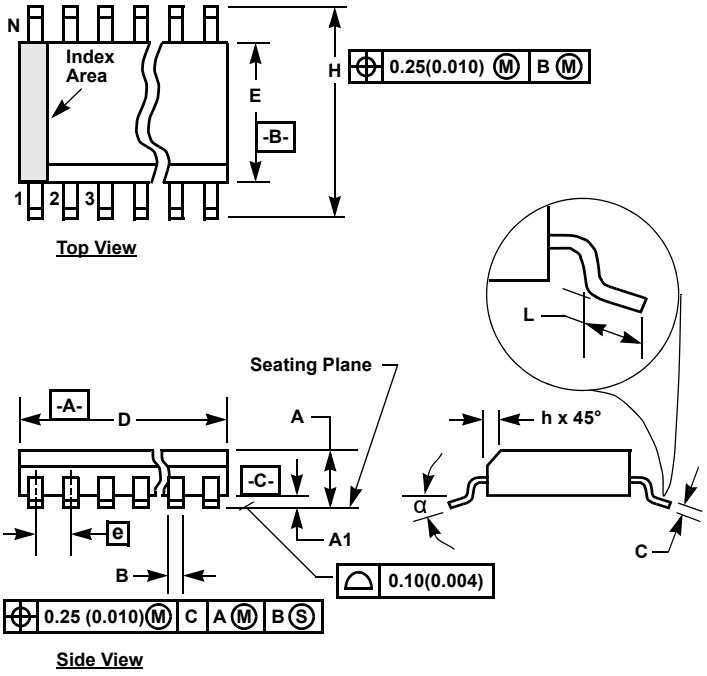
Revision History

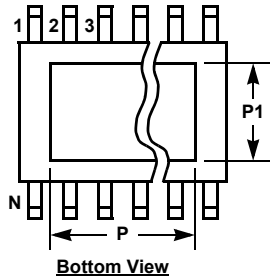
The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to the web to make sure that you have the latest revision.

DATE	REVISION	CHANGE
Aug 8, 2019	8.00	Updated links throughout document. Added Related Literature Removed ISL6506 information from document. Added tape and reel information to Ordering Information table and updated notes. Removed About Intersil section Updated M8.15C POD to the latest version, changes are as follows: -Updated Millimeter MIN and MAX values for A from: 1.43 MIN and 1.68 MAX to: 1.422 MIN and 1.700 MAX -Updated Inch MAX for A from: 0.066 to: 0.067 -A1 Inches changed MIN from: 0.001 to 0.0, and A1 Millimeters MIN from 0.03 to 0.0 -L Millimeter Min changed from: 0.41 to 0.406
Nov 10, 2015	7.00	Updated the Ordering Information Table on page 1. Added Revision History. Added the About Intersil section.

Package Outline Drawing

For the most recent package outline drawing, see M8.15C.





M8.15C
8 Lead Narrow Body Small Outline Exposed Pad Plastic Package (EPSOIC)

Symbol	Inches		Millimeters		Notes
	Min	Max	Min	Max	
A	0.056	0.067	1.422	1.700	-
A1	0.0	0.005	0.0	0.13	-
B	0.0138	0.0192	0.35	0.49	9
C	0.0075	0.0098	0.19	0.25	-
D	0.189	0.196	4.80	4.98	3
E	0.150	0.157	3.811	3.99	4
e	0.050 BSC		1.27 BSC		-
H	0.230	0.244	5.84	6.20	-
h	0.010	0.016	0.25	0.41	5
L	0.016	0.035	0.406	0.89	6
N	8		8		7
α	0°	8°	0°	8°	-
P	-	0.126	-	3.200	11
P1	-	0.099	-	2.514	11

Rev. 2 5/19

Notes:

7. Symbols are defined in the “MO Series Symbol List” in Section 2.2 of Publication Number 95.
8. Dimensioning and tolerancing per ANSI Y14.5M-1982.
9. Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusion, and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
10. Dimension “E” does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
11. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
12. “L” is the length of terminal for soldering to a substrate.
13. “N” is the number of terminal positions.
14. Terminal numbers are shown for reference only.
15. The lead width “B”, as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
16. Controlling dimension: Millimeter. Converted inch dimensions are not necessarily exact.
17. Dimensions “P” and “P1” are thermal and/or electrical enhanced variations. Values shown are maximum size of exposed pad within lead count and body size.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

© 2019 Renesas Electronics Corporation. All rights reserved.