



# Dual Output DC-DC & Linear Regulator IC

The 34710 is a dual-output power regulator IC integrating switching regulator, linear regulator, supervisory and power supply sequencing circuitry. With a wide operating input voltage range of 13 V to 32 V, the 34710 is applicable to many commercial and industrial applications using embedded MCUs.

A mode-selected 5.0 V or 3.3 V DC-DC switching regulator is provided for board-level I/O and user circuitry up to 700 mA. A linear regulator provides mode-selected core supply voltages of either 3.3V, 2.5V, 1.8V, or 1.5V at currents up to 500 mA.

The supervisor circuitry ensures that the regulator outputs follow a predetermined power-up and power-down sequence.

## Features

- Efficient 5.0 V/3.3 V Buck Regulator
- Low Noise LDO Regulator (mode-selected 3.3V, 2.5V, 1.8V, or 1.5V)
- On-Chip Thermal Shutdown Circuitry
- Supervisory Functions (Power-ON Reset and Error Reset Circuitry)
- Sequenced I/O and Core Voltages
- Pb-Free Packaging Designated by Suffix Code EW

**33710**  
**34710**

**DUAL OUTPUT DC-DC & LINEAR  
 REGULATOR**



**DW SUFFIX  
 EW SUFFIX (PB-FREE)  
 98ASA10627D  
 32-TERMINAL SOICW**

| ORDERING INFORMATION |                                     |             |
|----------------------|-------------------------------------|-------------|
| Device               | Temperature Range (T <sub>A</sub> ) | Package     |
| *PC33710EW/R2        | -40°C to 105°                       | 32 SOICW-EP |
| MC34710EW/R2         | 0°C to 85°C                         | 32 SOICW-EP |

\*Device in development.  
 Electrical parameters being defined.

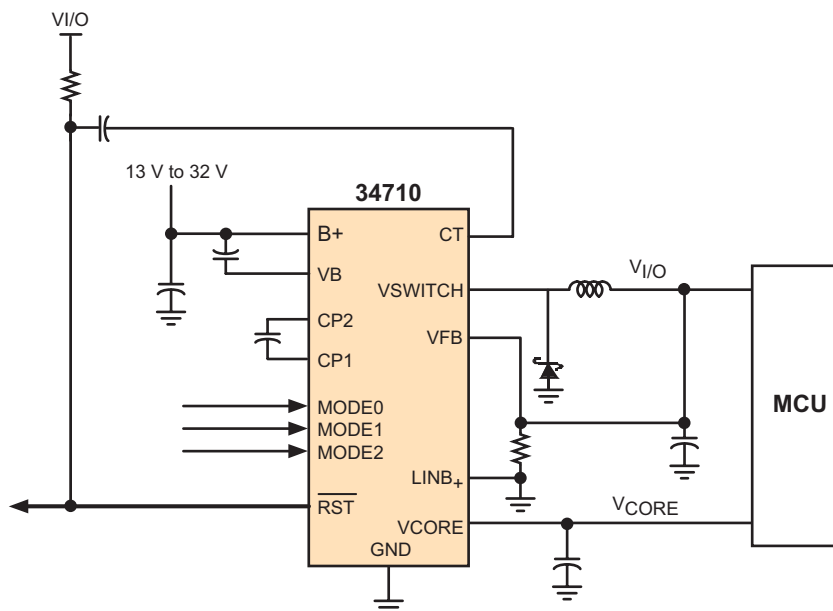


Figure 1. 34710 Simplified Application Diagram

\* This document contains certain information on a new product. Specifications and information herein are subject to change without notice.

### INTERNAL BLOCK DIAGRAM

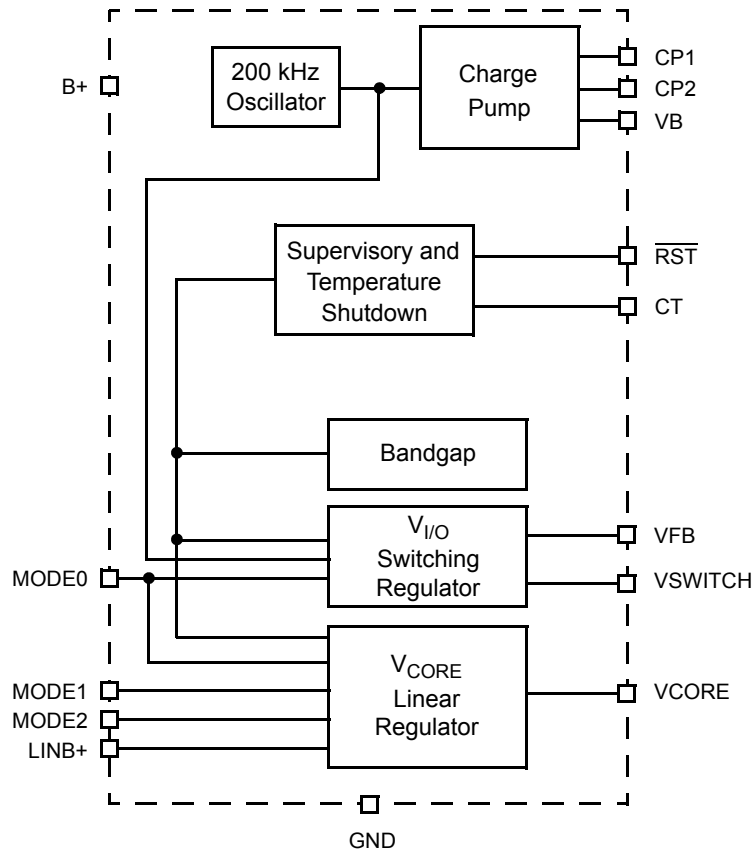
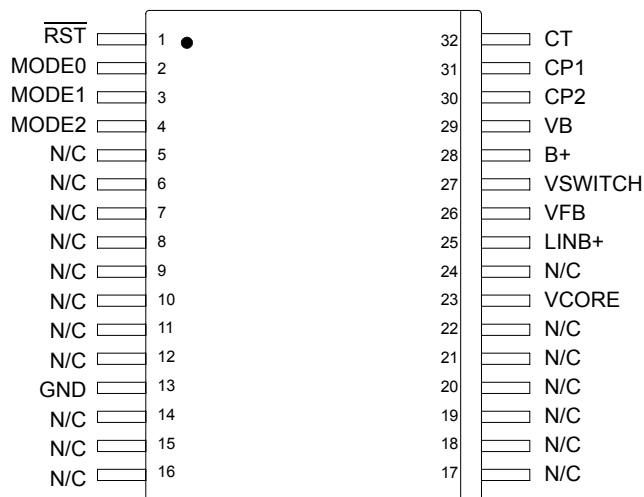


Figure 2. 34710 Simplified Internal Block Diagram

## TERMINAL CONNECTIONS



**Figure 3. 34710 Terminal Connections**

**Table 1. 34710 Terminal Definitions**

| Terminal Number    | Terminal Name           | Terminal Function | Formal Name  | Definition  |
|--------------------|-------------------------|-------------------|--|---|
| 1                  | $\overline{\text{RST}}$ | Reset             | Reset  | Reset is an open drain output only.   |
| 2<br>3<br>4        | Mode0<br>Mode1<br>Mode2 | Input             | Mode Control                                       | These input terminals control $V_{\text{FB}}$ and $V_{\text{CORE}}$ output voltages.  |
| 5–12,<br>14–22, 24 | NC                      | NC                | No Connects  | No internal connection to this terminal.  |
| 13                 | GND                     | Ground            | Ground   | Ground.   |
| 23                 | VCORE                   | Output            | Core Voltage Regulator Output                      | Core regulator output voltage.  |
| 25                 | LINB+                   | Input             | Core Voltage Regulator Input                       | Core regulator input voltage.   |
| 26                 | VFB                     | Input             | $V_{\text{I/O}}$ Switching Regulator Feedback      | Feedback terminal for $V_{\text{I/O}}$ switching regulator and internal logic supply. |
| 27                 | VSWITCH                 | Output            | $V_{\text{I/O}}$ Switching Regulator Switch Output | $V_{\text{I/O}}$ switching regulator switching output.                                |
| 28                 | B+                      | Input             | Power Supply Input                                 | Regulator input voltage.  |
| 29                 | VB                      | Output            | Boost Voltage                                      | Boost voltage storage node.   |
| 30                 | CP2                     | Passive Component | CP Capacitor Positive                              | Charge pump capacitor connection 2.   |
| 31                 | CP1                     | Passive Component | CP Capacitor Negative                              | Charge pump capacitor connection 1.   |
| 32                 | CT                      | Passive Component | Reset Delay Capacitor                              | Reset delay adjustment capacitor.   |

## MAXIMUM RATINGS

### MAXIMUM RATINGS

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

| Rating | Symbol | Max | Unit |
|--------|--------|-----|------|
|--------|--------|-----|------|

#### ELECTRICAL RATINGS

|   |   |                 |      |
|---|---|-----------------|------|
| Input Power Supply Voltage<br>$I_{B+} = 0.0 \text{ A}$  | $V_{B+}$  | -0.3 to 36      | V    |
| Terminal Soldering Temperature <sup>(1)</sup>   | $T_{\text{SOLDER}}$   | 260             | °C   |
| Power Dissipation <sup>(2)</sup>  | $P_D$   | 3.0             | W    |
| ESD Standoff Voltage<br>Non-Operating, Unbiased, Human Body Model <sup>(3)</sup>  | $V_{\text{ESD1}}$   | ±2000           | V    |
| Thermal Resistance<br>Junction-to-Ambient <sup>(4)</sup><br>Junction-to-Ambient <sup>(2)</sup><br>Junction-to-Exposed-Pad | $R_{\theta\text{JA}}$<br>$R_{\theta\text{JA}}$<br>$R_{\theta\text{JC}}$ | 45<br>25<br>2.0 | °C/W |

#### THERMAL RATINGS

|   |                    |          |    |
|---|--------------------|----------|----|
| Operating Ambient Temperature   | $T_A$              | 0 to 85  | °C |
| Operating Junction Temperature  | $T_J$              | 0 to 105 | °C |
| Input Power Supply Voltage<br>$I_{B+} = 0.0 \text{ A to } 3.0 \text{ A}$                  | $V_{B+}$           | 13 to 32 | V  |
| Quiescent Bias Current from B+ <sup>(5)</sup><br>$V_{B+} = 13 \text{ V to } 32 \text{ V}$ | $I_{B+}(\text{Q})$ | 7.5      | mA |

#### $V_{I/O}$ SWITCHING REGULATOR <sup>(6)</sup>

|  |                           |            |    |
|--|---------------------------|------------|----|
| Maximum Output Voltage Startup Overshoot ( $C_{\text{OUT}} = 330 \mu\text{F}$ )<br>Mode0 = 0<br>Mode0 = Open | $V_{I/O}(\text{STARTUP})$ | 5.4<br>3.6 | V  |
| Maximum Output Current<br>$T_A = 0^\circ\text{C to } 105^\circ\text{C}$                                      | $I_{V_{I/O}}$             | 700        | mA |

#### Notes

- Soldering temperature limit is for 10 seconds maximum duration. Not designed for immersion soldering. Exceeding these limits may cause malfunction or permanent damage to the device.
- With 2.0 in<sup>2</sup> of copper heatsink.
- ESD1 testing is performed in accordance with the Human Body Model ( $C_{\text{ZAP}} = 100 \text{ pF}$ ,  $R_{\text{ZAP}} = 1500 \Omega$ ).
- With no additional heatsinking.
- Maximum quiescent power dissipation is 0.25 W.
- $13 \text{ V} \leq V_{B+} \leq 32 \text{ V}$  and  $-20^\circ\text{C} \leq T_J \leq 145^\circ\text{C}$  unless otherwise noted.

**MAXIMUM RATINGS (continued)**

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

| Rating  | Symbol                      | Max                       | Unit |
|---|-----------------------------|---------------------------|------|
| <b>V<sub>CORE</sub> LINEAR REGULATOR</b> <sup>(7)</sup>   |                             |                           |      |
| Maximum Output Voltage Startup Overshoot (C <sub>OUT</sub> = 10 μF) <sup>(8)</sup><br>Mode2=Low, Mode1=Low, Mode0=Low<br>Mode2=Open, Mode1=Low, Mode0=Don't Care<br>Mode2=Low, Mode1=Open, Mode0=Don't Care<br>Mode2=Open, Mode1=Open, Mode0=Don't Care | V <sub>CORE</sub> (STARTUP) | 3.6<br>2.7<br>2.0<br>1.65 | V    |
| Maximum Output Current<br>T <sub>J</sub> = 0°C to 105°C, V <sub>LINB+</sub> ≤ V <sub>CORE</sub> (NOM) + 0.8 V <sup>(9)</sup>  | I <sub>VCORE</sub>          | 500                       | mA   |

## Notes

7.  $13\text{ V} \leq V_{B+} \leq 32\text{ V}$  and  $-20^\circ\text{C} \leq T_J \leq 145^\circ\text{C}$  unless otherwise noted.
8. Refer to [Table 2](#), page [9](#).
9. Pulse testing with low duty cycle used.

## STATIC ELECTRICAL CHARACTERISTICS

### STATIC ELECTRICAL CHARACTERISTICS

Characteristics noted under conditions  $4.75\text{ V} \leq V_{I/O} \leq 5.25\text{ V}$ ,  $13\text{ V} \leq V_{B+} \leq 32\text{ V}$ , and  $0^\circ\text{C} \leq T_J \leq 105^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

| Characteristic   | Symbol                               | Min         | Typ         | Max         | Unit     |
|--|--------------------------------------|-------------|-------------|-------------|----------|
| <b>SWITCHING REGULATOR (V<sub>I/O</sub>, MODE0)</b>  |                                      |             |             |             |          |
| Logic Supply Voltage ( $I_{V_{I/O}} = 25$ to $700\text{ mA}$ )<br>Mode0 = 0<br>Mode0 = Open (floating)                                     | $V_{I/O}$                            | 4.8<br>3.15 | 5.0<br>3.25 | 5.2<br>3.45 | V        |
| Output On Resistance<br>$V_{B+} = 13\text{ V}$ to $32\text{ V}$  | $R_{DS(ON)}$                         | 0.5         | 1.0         | 2.0         | $\Omega$ |
| Soft Start Threshold Voltage<br>Mode0 = any  | $V_{I/O(SOFT)}$                      | –           | 2.5         | 3.1         | V        |
| Current Limit Threshold ( $T_J = 25^\circ\text{C}$ to $100^\circ\text{C}$ )<br>Normal Operation<br>Soft Start, $V_{I/O} \leq 2.5\text{ V}$ | $I_{LIMIT(OP)}$<br>$I_{LIMIT(SOFT)}$ | 1.9<br>1.0  | 2.4<br>–    | 2.9<br>1.9  | A        |
| Minimum Voltage Allowable on $V_{SWITCH}$ Terminal<br>$T_J = 25^\circ\text{C}$ to $100^\circ\text{C}$                                      | $V_{VSWITCH(MIN)}$                   | -0.5        | –           | –           | V        |

### LINEAR REGULATOR (V<sub>CORE</sub>, MODE 1, 2, 3, 4)

|   |                         |                              |                          |                               |    |
|---|-------------------------|------------------------------|--------------------------|-------------------------------|----|
| Supply Voltage ( $I_{V_{CORE}} = 5.0\text{ mA}$ ) <sup>(10)</sup><br>Mode2=Low, Mode1=Don't Care, Mode0=Low<br>Mode2=Low, Mode1=Don't Care, Mode0=Open<br>Mode2=Open, Mode1=Don't Care, Mode0=Low<br>Mode2=Open, Mode1=Don't Care, Mode0=Open | $V_{CORE(NOM)}$         | 3.15<br>2.45<br>1.7<br>1.425 | 3.3<br>2.5<br>1.8<br>1.5 | 3.45<br>2.75<br>2.05<br>1.575 | V  |
| Supply Voltage ( $I_{V_{CORE}} = 500\text{ mA}$ ) <sup>(10)</sup><br>Mode2=Low, Mode1=Don't Care, Mode0=Low<br>Mode2=Low, Mode1=Don't Care, Mode0=Open<br>Mode2=Open, Mode1=Don't Care, Mode0=Low<br>Mode2=Open, Mode1=Don't Care, Mode0=Open | $V_{CORE(NOM)}$         | 3.0<br>2.2<br>1.55<br>1.33   | –<br>–<br>–<br>–         | 3.4<br>2.6<br>1.9<br>1.53     | V  |
| $V_{CORE}$ Dropout Voltage<br>$V_{CORE} = V_{CORE(NOM)}$ , $I_{V_{CORE}} = 0.5\text{ A}$  | $I_{V_{CORE}(DROPOUT)}$ | –                            | 0.5                      | 0.8                           | V  |
| Normal Current Limit Threshold<br>$T_J = 25^\circ\text{C}$ to $100^\circ\text{C}$ , $V_{LINB+} = V_{CORE(NOM)} + 1.0\text{ V}$  | $I_{LIMIT}$             | 600                          | 800                      | 1000                          | mA |

Notes

10. Refer to [Table 2](#), page [9](#).

**STATIC ELECTRICAL CHARACTERISTICS (continued)**

Characteristics noted under conditions  $4.75\text{ V} \leq V_{IO} \leq 5.25\text{ V}$ ,  $13\text{ V} \leq V_{B+} \leq 32\text{ V}$ , and  $0^\circ\text{C} \leq T_J \leq 105^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**MODE TERMINALS OPERATING VOLTAGES**

|   |                                 |     |     |       |   |
|---|---------------------------------|-----|-----|-------|---|
| Mode Control Terminals Low Voltage  | $V_{IL}(\text{Mode}_n)$         | –   | –   | 0.825 | V |
| Mode Control Terminals High Voltage   | $V_{IH}(\text{Mode}_n)$         | 2.6 | –   | –     | V |
| Mode Control Terminals Voltage with Input Floating<br>$V_{B+} = 13\text{ V to }14\text{ V}$ | $V_{\text{Mode}}(\text{FLOAT})$ | 7.0 | 8.0 | 13    | V |

**SUPERVISOR CIRCUITRY ( $\overline{\text{RST}}$ ,  $V_{\text{CORE}}$ )**

|   |  |  |        |   |                  |
|---|--|--|--------|---|------------------|
| Minimum Function $V_{B+}$ for Charge Pump and Oscillator Running  | $V_{B+}(\text{MIN})$                     | –  | –      | 9.0   | V                |
| Minimum $V_{B+}$ for $\overline{\text{RST}}$ Assertion, $V_{B+}$ Rising   | $V_{B+}(\text{ASSERT})$                  | –  | 1.9    | 2.2   | V                |
| $\overline{\text{RST}}$ Low Voltage<br>$V_{B+} = 2.0\text{ V}$ , $I_{\overline{\text{RST}}} \leq 5.0\text{ mA}$ | $V_{\text{OL}}$                          | –  | 0.25   | 0.4   | V                |
| $\overline{\text{RST}}$ $V_{IO}$ Threshold<br>$V_{IO}$ Rising<br>$V_{IO}$ Falling                               | $V_{IO\text{T}+}$<br>$V_{IO\text{T}-}$   | –<br>$V_{IO}(\text{NOM})$<br>– 300 mV          | –<br>– | $V_{IO}(\text{NOM})$<br>– 50 mV<br>–          | V                |
| $\overline{\text{RST}}$ Hysteresis for $V_{IO}$   | $V_{\text{HYS}V_{IO}}$                   | 10   | –      | 100   | mV               |
| $\overline{\text{RST}}$ $V_{\text{CORE}}$ Threshold<br>$V_{\text{CORE}}$ Rising<br>$V_{\text{CORE}}$ Falling    | $V_{\text{CORE}+}$<br>$V_{\text{CORE}-}$ | –<br>$V_{\text{CORE}}(\text{NOM})$<br>– 300 mV | –<br>– | $V_{\text{CORE}}(\text{NOM})$<br>– 30 mV<br>– | V                |
| $\overline{\text{RST}}$ Hysteresis for $V_{\text{CORE}}$<br>$V_{B+} = 13\text{ V to }32\text{ V}$               | $V_{\text{HYS CORE}}$                    | 10   | 50     | 100   | mV               |
| $V_{\text{CORE}} - V_{IO}$ for $V_{\text{CORE}}$ Shutdown<br>$V_{B+} = 13\text{ V to }32\text{ V}$              | $V_{\text{CORE}}(\text{SHUTDOWN})$       | 0.5  | –      | 0.9   | V                |
| Thermal Shutdown Temperature<br>$T_J$ Rising  | $T_J(\text{TSD})$                        | –  | –      | 170   | $^\circ\text{C}$ |
| Overtemperature Hysteresis  | $T_J(\text{HYSTERESIS})$                 | –  | 20     | –   | $^\circ\text{C}$ |

**VB CHARGE PUMP**

|   |                |                         |                         |                          |   |
|---|----------------|-------------------------|-------------------------|--------------------------|---|
| Boost Voltage <sup>(11)</sup><br>$V_{B+} = 12\text{ V}$ , $I_{Vb} = 0.5\text{ mA}$<br>$V_{B+} = 32\text{ V}$ , $I_{Vb} = 0.5\text{ mA}$ | $V_B$<br>$V_B$ | $V_{B+8}$<br>$V_{B+10}$ | $V_{B+9}$<br>$V_{B+12}$ | $V_{B+10}$<br>$V_{B+14}$ | V |
|---|----------------|-------------------------|-------------------------|--------------------------|---|

Notes

11. Bulk capacitor ESR  $\leq 10$  milliohms

## DYNAMIC ELECTRICAL CHARACTERISTICS

### DYNAMIC ELECTRICAL CHARACTERISTICS

Characteristics noted under conditions  $4.75\text{ V} \leq V_{IO} \leq 5.25\text{ V}$ ,  $13\text{ V} \leq V_{B+} \leq 32\text{ V}$ , and  $0^\circ\text{C} \leq T_J \leq 105^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

#### $V_{IO}$ SWITCHING REGULATOR

|  |            |    |    |    |    |
|--|------------|----|----|----|----|
| Duty Cycle   | D          | 45 | 49 | 55 | %  |
| Switching Rise and Fall Time<br>Load Resistance = $100\ \Omega$ , $V_{B+} = 30\text{ V}$ | $t_R, t_F$ | 20 | 35 | 50 | ns |

#### SUPERVISOR CIRCUITRY (RST)

|  |  |            |            |            |                    |
|--|--|------------|------------|------------|--------------------|
| $\overline{\text{RST}}$ Delay<br>$C_{\text{delay}} = 0.1\ \mu\text{F}$   | $t_{\text{DELAY}}$                     | 40         | 60         | 80         | ms                 |
| $\overline{\text{RST}}$ Filter Time<br>$V_{B+} = 9.0\text{ V}$   | $t_{\text{FILTER}}$                    | 2.0        | 4.0        | 8.0        | $\mu\text{s}$      |
| $\overline{\text{RST}}$ Fall Time<br>$C_L = 100\ \text{pF}$ , $R_{\text{PULLUP}} = 4.7\ \text{k}\Omega$ , 90% to 10% | $t_F$                                  | –          | 25         | 75         | ns                 |
| C Delay<br>Charge Current<br>Threshold Voltage   | $I_{\text{CDLY}}$<br>$V_{\text{THCD}}$ | 2.0<br>1.7 | 3.5<br>2.0 | 5.0<br>2.2 | $\mu\text{A}$<br>V |

#### INTERNAL OSCILLATOR

|   |                 |     |     |     |     |
|---|-----------------|-----|-----|-----|-----|
| Charge Pump and $V_{IO}$ Switching Regulator Operating Frequency<br>$V_{B+} = 12\text{ V}$ to $32\text{ V}$ | $f_{\text{OP}}$ | 140 | 170 | 260 | kHz |
|---|-----------------|-----|-----|-----|-----|



## FUNCTIONAL DESCRIPTION

## INTRODUCTION

**V<sub>I/O</sub> Switching Regulator**

The V<sub>I/O</sub> switching regulator output voltage is determined by the Mode digital input terminals. The 34710's Mode terminals select the output voltage. For example, if Mode2, Mode1, and Mode0 are set to 0, 0, 0 (respectively) then V<sub>I/O</sub> will be set to 5.0 V; if Mode2, Mode1, and Mode0 are all left floating (i.e., Open, Open, and Open), then the voltage for V<sub>I/O</sub> will be set to 3.3 V. [Table 2](#) provides the truth table for setting the various combination of regulator outputs via the Mode pins.

The topology of the regulator is a hysteretic buck regulator operating from the internal ~200 kHz oscillator.

**V<sub>CORE</sub> Linear Regulator**

The V<sub>CORE</sub> linear LDO (low drop-out) regulator can produce either a +3.3 V, 2.5 V, 1.8 V, or 1.5 V output voltage at currents up to 500 mA. The input to the V<sub>CORE</sub> regulator is a terminal that may be connected to the V<sub>I/O</sub> regulator output or to an external power supply. Note, the minimum input voltage level must be equal to or greater than the

selected V<sub>CORE</sub> voltage + 0.8 V. (i.e., 0.8V is the LDO regulator drop out voltage.)

The Mode terminals select the output voltage as depicted in [Table 2](#).

**Table 2. V<sub>I/O</sub> and V<sub>CORE</sub> Regulator Output Voltage Selection**

| Mode2 | Mode1 | Mode0 | V <sub>I/O</sub> (V) | V <sub>CORE</sub> (V) |
|-------|-------|-------|----------------------|-----------------------|
| 0     | 0     | 0     | 5.0                  | 3.3                   |
| 0     | 0     | Open  | 3.3                  | 2.5                   |
| 0     | Open  | 0     | 5.0                  | 1.8                   |
| 0     | Open  | Open  | 3.3                  | 1.8                   |
| Open  | 0     | 0     | 5.0                  | 2.5                   |
| Open  | 0     | Open  | 3.3                  | 2.5                   |
| Open  | Open  | 0     | 5.0                  | 1.5                   |
| Open  | Open  | Open  | 3.3                  | 1.5                   |

Open indicates terminal is not connected externally (i.e. floating).

## FUNCTIONAL TERMINAL DESCRIPTION

**Power Supply Input (B+)**

Main supply voltage for the V<sub>I/O</sub> Switching Regulator and general chip bias circuitry.

**Core Voltage Regulator Input (Lin B+)**

Supply voltage for the V<sub>CORE</sub> Regulator. May be provided by the V<sub>I/O</sub> regulator output or from an independent supply.

**Mode Control (MODE 0,1,2)**

Mode select terminals to select the V<sub>I/O</sub> and V<sub>CORE</sub> output voltages per table 2. Pull to ground for low state, float for high state.

**Switching Capacitors 1 and 2 (CP1/CP2)**

Terminals for the Charge Pump capacitor.

**Boost Voltage (VB)**

The Boost Voltage is an output terminal used for the charge pump boost voltage and is a connection point for the Charge Pump bulk capacitor. It provides a gate drive for the V<sub>I/O</sub> Switch FET.

**Reset ( $\overline{\text{RST}}$ )**

Reset is an output terminal for supervisory functions. This terminal is in high state during normal operation and low state

during fault conditions. This terminal has no input function and requires an external pull-up resistor.

The  $\overline{\text{RST}}$  terminal is an open drain output driver to prevent oscillations during the transition. It is recommended to connect a 0.1 uF capacitor between the CT pin and  $\overline{\text{RST}}$  pin. Note: error conditions must be present for a minimum time, t<sub>FILTER</sub>, before the 34710 responds to them. Once all error conditions have been cleared,  $\overline{\text{RST}}$  is held low for an additional time of t<sub>DELAY</sub>.

**Reset Delay Capacitor (CT)**

This terminal is the external delay. It is used with a capacitor to ground to delay  $\overline{\text{RST}}$  turn-on time and to  $\overline{\text{RST}}$  to prevent  $\overline{\text{RST}}$  oscillations during chip power-on.

**V<sub>I/O</sub> Switching Regulator Feedback (VFB)**

This terminal is the feedback input for the V<sub>I/O</sub> Switching Regulator and the output of the regulator application.

**V<sub>I/O</sub> Switching Regulator output (VSWITCH)**

This terminal is the Switching output for the V<sub>I/O</sub> Buck Regulator. It has internal high side FET.

## SUPERVISORY FUNCTIONS

### Supervisory Circuitry

The supervisory circuitry provides control of the  $\overline{\text{RST}}$  line, an open drain signal, based on system operating conditions monitored by the 34710.  $V_{\text{I/O}}$ ,  $V_{\text{CORE}}$ ,  $V_{\text{B+}}$ , and thermal shutdown (TSD) detectors in various parts of the chip are monitored for error conditions.  $V_{\text{I/O}}$ ,  $V_{\text{CORE}}$ ,  $V_{\text{B+}}$ , and thermal shutdown have both positive- and negative-going thresholds for triggering the reset function.

The supervisor circuitry also ensures that the regulator outputs follow a predetermined power-up and power-down sequence. Specifically, the sequencing ensures that  $V_{\text{I/O}}$  is never less than 0.9 V below  $V_{\text{CORE}}$ . This means that  $V_{\text{CORE}} - V_{\text{I/O}}$  will be clamped at 0.5 V, and that the  $V_{\text{CORE}}$  regulator

operation will be suppressed during startup and shutdown to ensure that  $V_{\text{CORE}} - V_{\text{I/O}} = 0.9 \text{ V}$ .

### VB Charge Pump

The high-side MOSFET in the switching regulator (buck converter) requires a gate drive supply voltage that is biased higher than the B+ voltage, and this boosted voltage is provided by the internal charge pump and stored in a capacitor between the VB pin and the B+ pin. The charge pump operates directly from the B+ supply, and uses an internal oscillator operating at 200 kHz.

### Internal Oscillator

The internal oscillator provides a 200 kHz square wave signal for charge pump operation and for the buck converter.

## TYPICAL APPLICATIONS

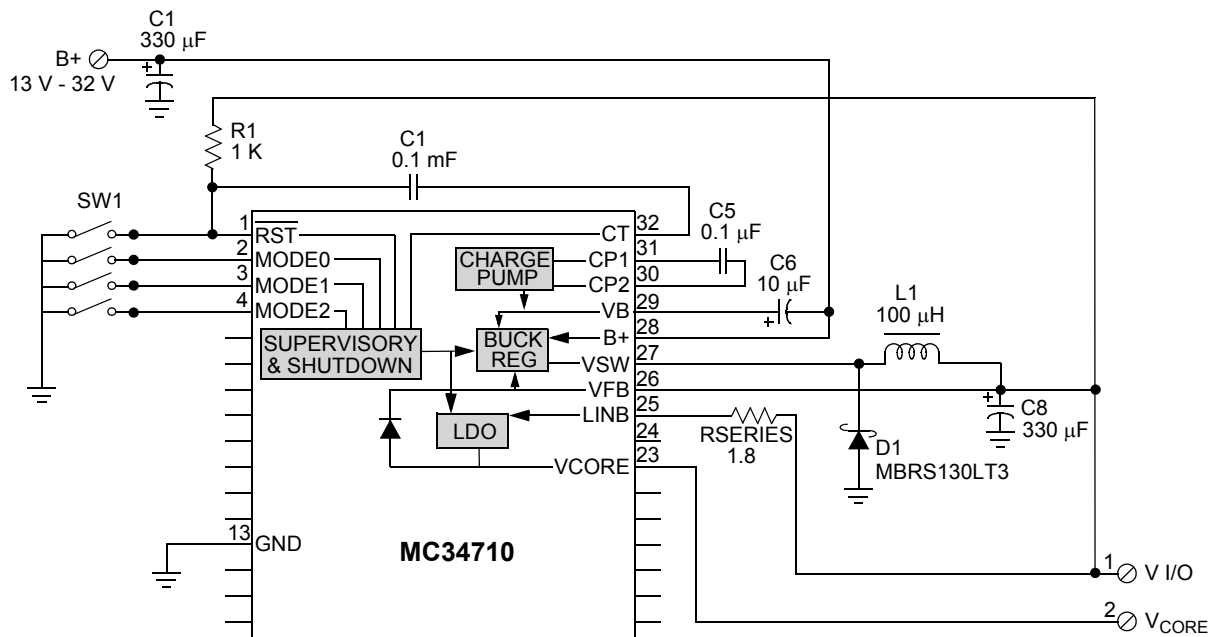


Figure 4. Typical Application Diagram

The MC34710 provides both a buck converter and an LDO regulator in one IC. Figure 4 above shows a typical application schematic for the MC34710. L1 is the buck converter's inductor. The buck inductor is a key component and must not only present the required reactance, but do so at a dc resistance of less than 20 milliohms in order to preserve the converter's efficiency. Also important to the converter's efficiency is the utilization of a low Vf Schottky diode for D1.

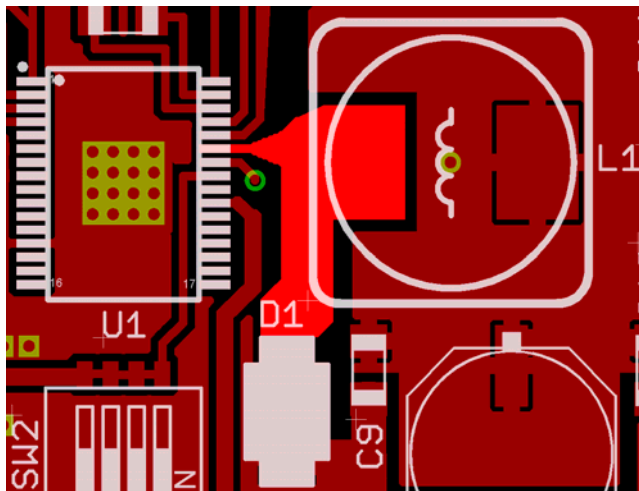
Note that a 0.1µF capacitor is connected between CT and the reset pins; this prevents any possibility of oscillations occurring on the reset line during transitions by allowing the CT terminal to discharge to ground potential via the RST pin, and then charge when RST returns to a logic high. The capacitor between the CP1 and CP2 pins is the charge pump's "bucket capacitor", and sequentially charges and discharges to pump up the reservoir capacitor connected to the VB pin. Note that the reservoir capacitor's cathode is connected to B+ rather than ground. Also note that the charge pump is intended only to provide gate-drive potential for the buck regulator's internal power MOSFET, and therefore connecting external loads to the VB pin is not recommended.

The IC's internal  $V_{CORE}$  LDO regulator can provide up to 500 mA of current as long as the operating junction

temperature is maintained below 105 degrees C. The heat-generating power dissipation of the LDO is primarily a function of the Volt x Amp product across the LINB+ and  $V_{CORE}$  terminals. Therefore, if the LINB+ voltage is  $\gg$  than the selected  $V_{CORE}$  voltage + 0.8 V, it is recommended to use a power resistor in series with the LINB+ input to drop the voltage and dissipate the heat externally from the IC. For example, if the output of the buck regulator (V I/O on the schematic) is used as the input to LINB+, and the mode switches are set such that V I/O = 5 V and  $V_{CORE}$  = 3.3 V, then a series resistance of 1.8 ohms at the LINB+ pin would provide an external voltage drop at 500 mA while still leaving the minimum required headroom of 0.8 V. Conversely, if the mode switches are set such that V I/O = 3.3 V and  $V_{CORE}$  = 2.5 V, then no series resistance would be required, even at the maximum output current of 500 mA.

Designing a power supply circuit with the MC34710, like all dc-dc converter ICs, requires special attention not only to component selection, but also to component placement (i.e., printed circuit board layout). The MC34710 has a nominal switching frequency of 200 kHz, and therefore pcb traces between the buck converter discrete component terminals and the IC should be kept as short and wide as possible to keep the parasitic inductance low. Likewise, keeping these

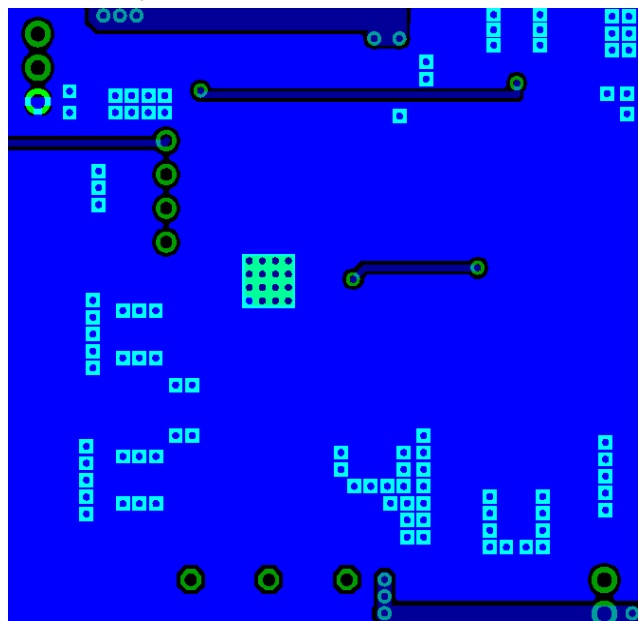
pcb traces short and wide helps prevent the converter's high di/dt switching transients from causing EMI/RFI.



**Figure 5. Typical PCB Layout**

Figure 5 shows a typical layout for the pcb traces connecting the IC's switching terminal (VSWITCH) and the power inductor, rectifier, and filter components.

Also, it is recommended to design the component layout so that the switching currents can be immediately sunk into a broad full-plane ground that provides terminations physically right at the corresponding component leads. This helps prevent switching noise from propagating into other sections of the circuitry.

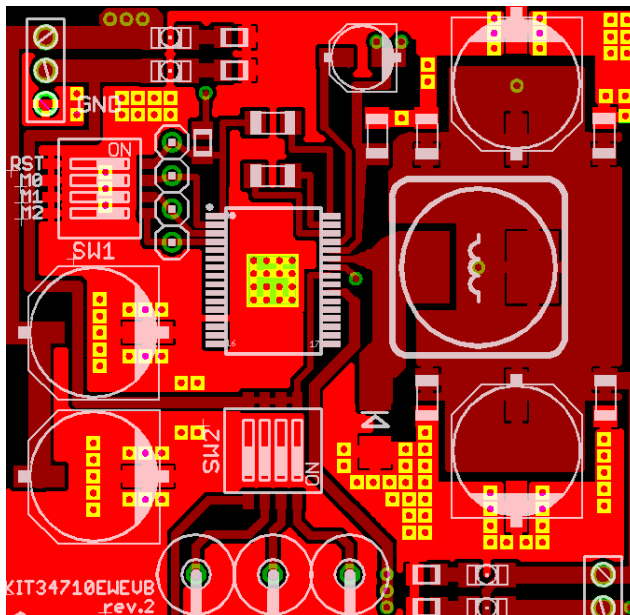


**Figure 6. Bottom Copper Layout**

Figure 6 illustrates a pcb typical bottom copper layout for the area underneath a buck converter populated on the top of the same section of pcb.

The ground plane is highlighted so the reader may note how the ground plane has been kept as broad and wide as

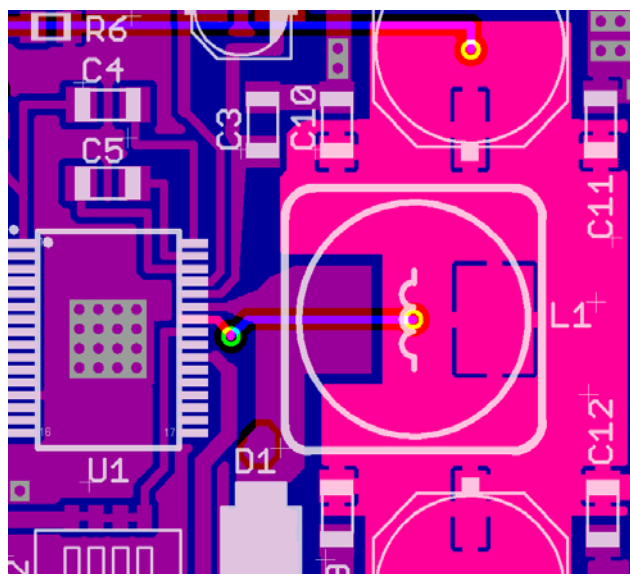
possible. The square vias in the plane are located to provide an immediate path to ground from the top copper circuitry.



**Figure 7. Top Copper Layout**

Figure 7 shows the corresponding top copper circuit area with the component placement.

Again, the ground plane and the vias have been highlighted so the reader may note the proximity of these current sink pathways to the key converter components. It is also important to keep the power planes of the switching converter's output spread as broad as possible beneath the passive components, as this helps reduce EMI/RFI and the potential for coupling noise transients into adjacent circuitry.



**Figure 8. Output Plane of Buck Converter**

Figure 8 shows the output plane of the buck converter highlighted.

This layout provides the lowest possible impedance as well as lowest possible dc resistance for the power routing. Note that the power path and its return should be placed, if possible, on top of each other on different layers or opposite sides of the pcb.

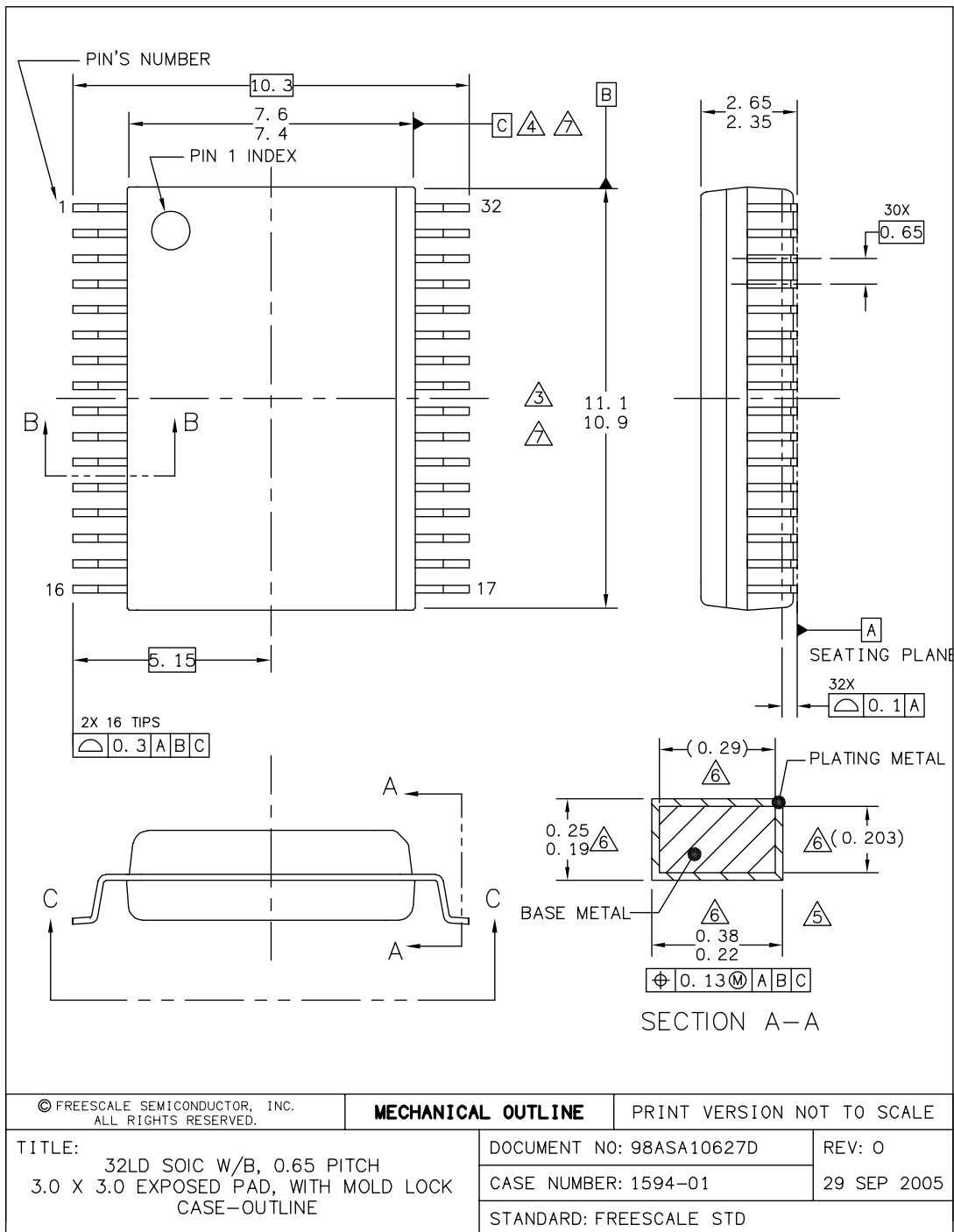
Small ceramic capacitors are placed in parallel with the Aluminum electrolytics so that the overall bulk filtering presents a low ESL to the high di/dt switching currents. Alternatively, special low ESL/ESR switching-grade electrolytics may be used.

An additional feature of the MC34710 is the 32 SOICW-EP exposed pad package. The package allows heat to be conducted from the die down through the exposed metal pad underneath the package and into the copper of the pcb. In order to best take advantage of this feature, a grid array of thru-hole vias should be placed in the area corresponding to the exposed pad, and these vias then should then connect to a large ground plane of copper to dissipate the heat into the ambient environment. An example of these vias can be seen in the previous figures of a typical pcb layout.

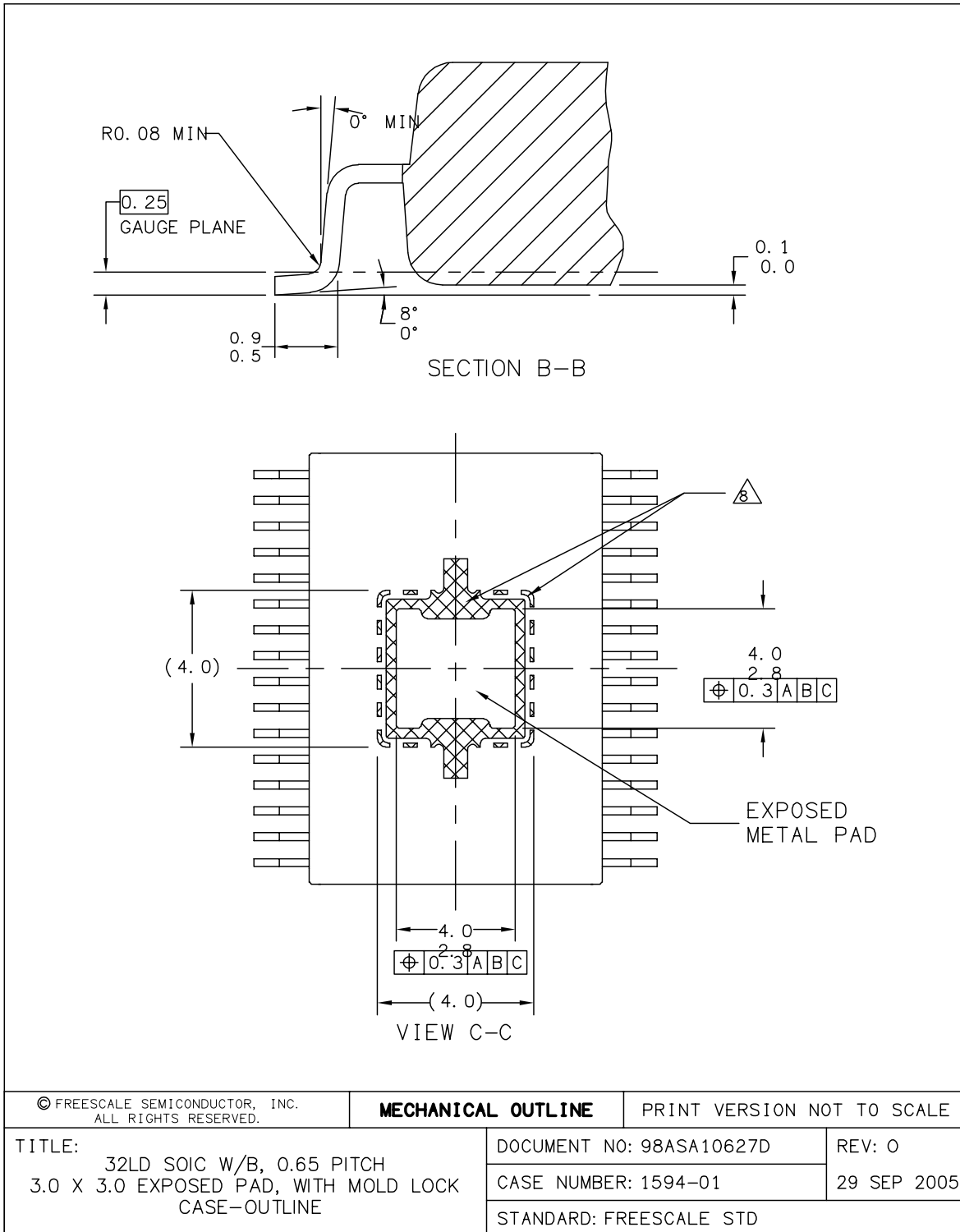
# PACKAGING

## PACKAGE DIMENSIONS

EW (Pb-FREE) SUFFIX  
32-LEAD SOICW-EXPOSED PAD  
PLASTIC PACKAGE  
98ASA10627D  
ISSUE O



**EW (Pb-FREE) SUFFIX**  
**32-LEAD SOICW-EXPOSED PAD**  
**PLASTIC PACKAGE**  
**98ASA10627D**  
**ISSUE 0**



**REVISION HISTORY**

| REVISION | DATE   | DESCRIPTION OF CHANGES   |
|----------|--------|--|
| 2.0      | 3/2006 | <ul style="list-style-type: none"><li>• Converted to Freescale format</li><li>• Updated Maximum Ratings, Static and Dynamic Characteristics tables.</li><li>• Updated packaging drawing</li><li>• Changed terminal VI/O_OUT to VFB</li><li>• Implemented Revision History page</li></ul> |
| 3.0      | 3/2006 | <ul style="list-style-type: none"><li>• Updated format from Preliminary to Advance Information.</li><li>• Format and style corrections to match standard template.</li></ul>   |



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[support@freescale.com](mailto:support@freescale.com)

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Freescale Semiconductor Japan Ltd.  
Headquarters  
ARCO Tower 15F  
1-8-1, Shimo-Meguro, Meguro-ku,  
Tokyo 153-0064  
Japan  
0120 191014 or +81 3 5437 9125  
[support.japan@freescale.com](mailto:support.japan@freescale.com)

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