

Preliminary Information

Adjustable Dual Output Switching Power Supply

The 34710 is a dual-output power regulator IC that integrates a switching regulator, a linear regulator, supervisor circuitry, and a power supply sequencer. With a wide operating input voltage range of 12 V to 32 V and robust temperature limits, the 34710 is applicable in many commercial and industrial applications that use an MCU.

A user-selectable 5.0 V/3.3 V buck switching regulator is provided for board-level I/Os and user circuitry. The regulator is capable of delivering up to 1.0 A. The MCU core voltage is an adjustable 3.3 V/2.5 V/1.8 V/1.5 V linear voltage regulator that can supply up to 500 mA.

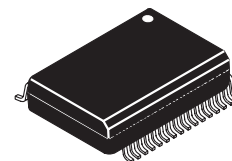
The switching and linear regulator output voltage are determined through three digital input mode terminals that can be controlled by an MCU.

Features

- High-Current Adjustable 5.0 V/3.3 V Switching Regulator
- Low Noise User-Selectable 3.3 V/2.5 V/1.8 V/1.5 V Linear Regulator
- On-Chip Thermal Shutdown and Error Reset Circuitry
- Supervisory Functions (Power-ON Reset and Error Reset Circuitry)
- Sequenced I/O and Core Voltages
- Pb-Free Packaging Designated by Suffix Code EW

34710

ADJUSTABLE DUAL OUTPUT
SWITCHING POWER SUPPLY

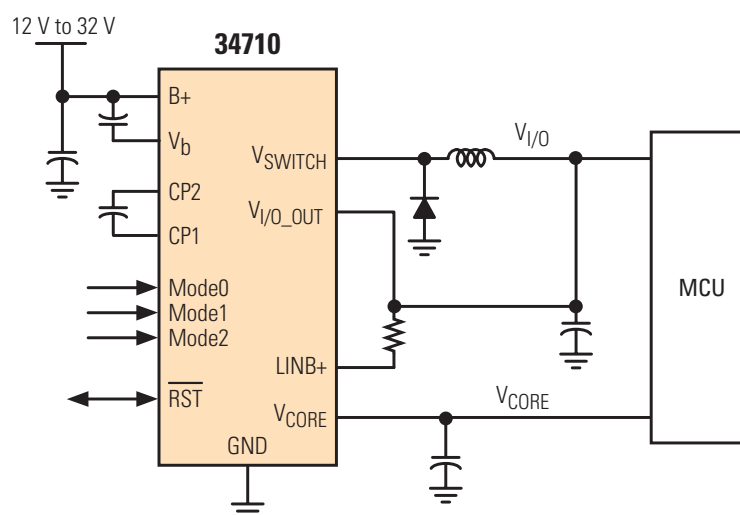


EW (Pb-FREE) SUFFIX
CASE 1324-02
32-LEAD SOICW-EP

ORDERING INFORMATION

Device	Temperature Range (T _A)	Package
PC34710EW/R2	0°C to 85°C	32 SOICW-EP

34710 Simplified Application Diagram



This document contains information on a product under development.
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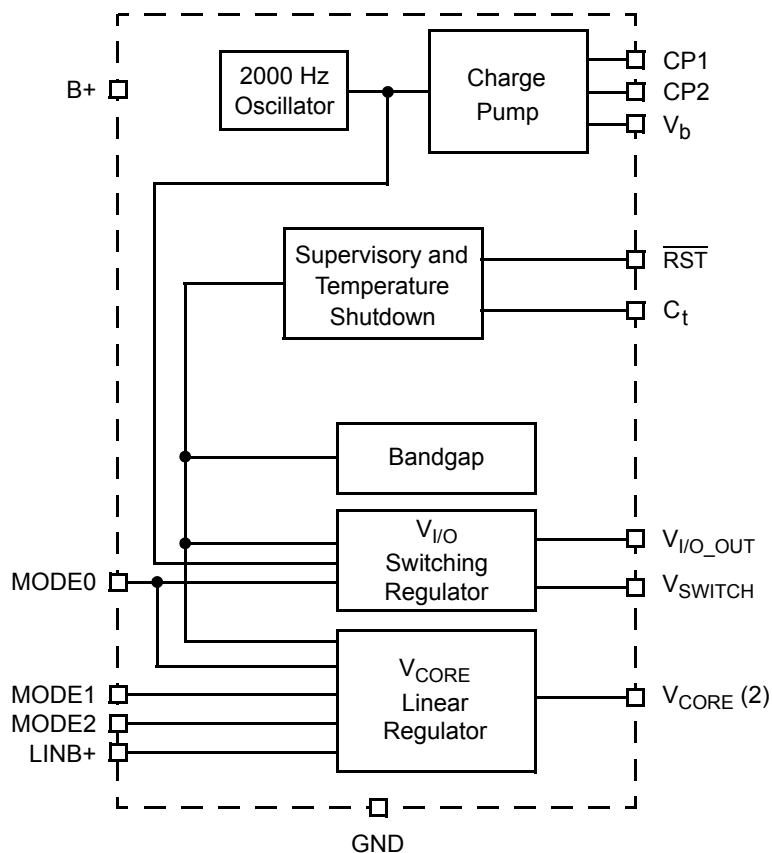
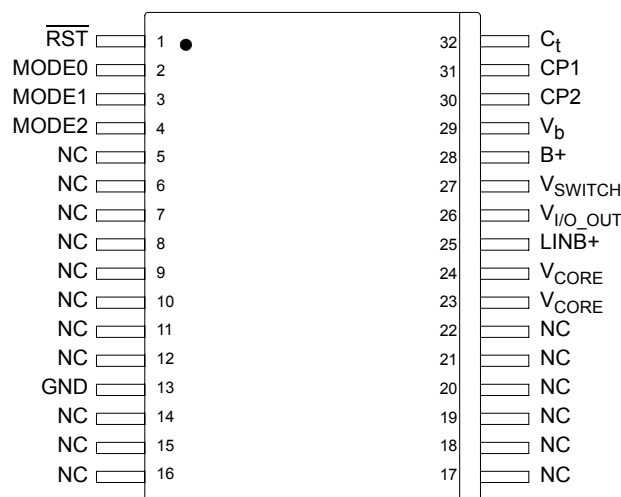


Figure 1. 34710 Simplified Internal Block Diagram

Freescale Semiconductor, Inc.



TERMINAL FUNCTION DESCRIPTION

Terminal	Terminal Name	Formal Name	Definition
1	$\overline{\text{RST}}$	Reset	Reset input and output. This terminal is open drain.
2 3 4	MODE0 MODE1 MODE2	Mode Control	These input terminals control $V_{\text{I/O_OUT}}$ and V_{CORE} output voltages.
5–12, 14–22	NC	No Connects	No internal connection to this terminal.
13	GND	Ground	Ground.
23, 24	V_{CORE}	Core Voltage Regulator Output	Core regulator output voltage.
25	LINB+	Core Voltage Regulator Input	Core regulator input voltage.
26	$V_{\text{I/O_OUT}}$	$V_{\text{I/O}}$ Switching Regulator Feedback	Feedback terminal for $V_{\text{I/O}}$ switching regulator and internal logic supply.
27	V_{SWITCH}	$V_{\text{I/O}}$ Switching Regulator Switch Output	$V_{\text{I/O}}$ switching regulator switching output.
28	B+	Power Supply Input	Regulator input voltage.
29	V_b	Boost Voltage	Boost voltage storage node.
30	CP2	Switching Capacitor 2	Charge pump capacitor connection 2.
31	CP1	Switching Capacitor 1	Charge pump capacitor connection 1.
32	C_t	Reset Delay Capacitor	Reset delay adjustment capacitor.

MAXIMUM RATINGS

All voltages are with respect to ground unless otherwise noted.

Rating	Symbol	Max	Unit
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GLOBAL ABSOLUTE MAXIMUM RATINGS

Input Power Supply Voltage $I_{B+} = 0 \text{ A}$	V_{B+}	-0.3 to 36	V
Terminal Soldering Temperature (Note 1)	T_{SOLDER}	260	°C
Power Dissipation (Note 2)	P_D	3.0	W
ESD Standoff Voltage Non-Operating, Unbiased, Human Body Model (Note 3)	V_{ESD1}	±2000	V
Thermal Resistance Junction-to-Ambient (Note 4) Junction-to-Ambient (Note 2) Junction-to-Case	$R_{\theta JA}$ $R_{\theta JA}$ $R_{\theta JC}$	45 25 2.0	°C/W

GLOBAL OPERATING RATINGS

Operating Ambient Temperature	T_A	0 to 85	°C
Operating Device Junction Temperature	T_J	105	°C
Input Power Supply Voltage $I_{B+} = 0 \text{ A}$ to 3.0 A	V_{B+}	12 to 32	V
Quiescent Bias Current from B+ (Note 5) $V_{B+} = 12 \text{ V}$ to 32 V	$I_{B+(q)}$	7.5	mA
Operating Junction Temperature	T_J	-0 to 105	°C

$V_{I/O}$ SWITCHING REGULATOR (Note 6)

Maximum Output Voltage Startup Overshoot ($C_{OUT} = 330 \mu\text{F}$) MODE0 = 0 MODE0 = Open	$V_{I/O}(\text{STARTUP})$	5.4 3.6	V
Maximum Output Current $T_A = 0^\circ\text{C}$ to 105°C	$I_{V/I/O}$	1.2	A

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 in² of copper heatsink.
- ESD1 testing is performed in accordance with the Human Body Model ($C_{ZAP} = 100 \text{ pF}$, $R_{ZAP} = 1500 \Omega$).
- With no additional heatsinking.
- Maximum quiescent power dissipation is 0.25 W.
- $12 \text{ V} \leq V_{B+} \leq 32 \text{ V}$ 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.

Rating	Symbol	Max	Unit
V_{CORE} LINEAR REGULATOR (Note 7)			
Maximum Output Voltage Startup Overshoot (C _{OUT} = 10 μF) (Note 8) MODE[2:0] = [0, x, 0] MODE[2:0] = [0, x, Open] MODE[2:0] = [Open, x, 0] MODE[2:0] = [Open, x, Open]	V _{CORE} (STARTUP)	3.6 2.7 2.0 1.65	V
Maximum Output Current T _J = 0°C to 105°C, V _{LINB+} ≤ V _{CORE} (NOM) + 0.8 V (Note 9)	I _{VCORE}	500	mA

Notes

7. 12 V ≤ V_{B+} ≤ 32 V and -20°C ≤ T_J ≤ 145°C unless otherwise noted.
8. Refer to [Table 1](#), page 10.
9. Pulse testing with low duty cycle used.

STATIC ELECTRICAL CHARACTERISTICS

Characteristics noted under conditions $4.75\text{ V} \leq V_{IO} \leq 5.25\text{ V}$, $12\text{ V} \leq V_{B+} \leq 32\text{ V}$, 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
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V_{IO} SWITCHING REGULATOR

Logic Supply Voltage ($I_{VIO} = 25\text{ mA to } 1.0\text{ A}$) MODE0 = 0 MODE0 = Open	V_{IO}	4.8 3.15	– –	5.2 3.45	V
Logic Supply Current $V_{IO} = \text{Nominal}$, Power Dissipation in Switching Regulator = 0.45 W	I_{VIO}	0.025	–	1.0	A
Output On Resistance $V_{B+} = 12\text{ V to } 32\text{ V}$	$R_{DS(ON)}$	0.5	TBD	2.0	Ω
Soft Start Threshold Voltage MODE0 = X	$V_{IO}(\text{SOFT})$	–	–	2.5	V
Current Limit Threshold ($T_J = 25^\circ\text{C to } 100^\circ\text{C}$) Normal Operation Soft Start, $V_{IO} \leq 2.5\text{ V}$	$I_{LIMIT(OP)}$ $I_{LIMIT(SOFT)}$	2.1 1.3	– –	3.2 1.8	A
Minimum Voltage Allowable on V_{SWITCH} Terminal $T_J = 25^\circ\text{C to } 100^\circ\text{C}$	$V_{VSWITCH(MIN)}$	-0.5	–	–	V

V_{CORE} LINEAR REGULATOR

Supply Voltage ($I_{VCORE} = 5.0\text{ mA to } 500\text{ mA}$) (Note 10) MODE[2:0] = [0, x, 0] MODE[2:0] = [0, x, Open] MODE[2:0] = [Open, x, 0] MODE[2:0] = [Open, x, Open]	$V_{CORE(NOM)}$	3.15 2.35 1.71 1.425	– – – –	3.45 2.65 1.89 1.575	V
Supply Current $V_{CORE} = V_{CORE(NOM)}$	I_{VCORE}	1.0	–	500	mA
V_{CORE} Dropout Voltage $V_{CORE} = V_{CORE(NOM)}$, $I_{VCORE} = 0.5\text{ A}$	$I_{VCORE(DROPOUT)}$	0.8	–	–	V
Regulator Input Voltage $V_{CORE} = V_{CORE(NOM)}$, $I_{VCORE} = 0.5\text{ A}$	V_{LINB+}	$V_{CORE(NOM)} + 1.0$	–	10	V
Normal Current Limit Threshold $T_J = 25^\circ\text{C to } 100^\circ\text{C}$, $V_{LINB+} = V_{CORE(NOM)} + 1.0\text{ V}$	I_{LIMIT}	800	–	1000	mA

Notes

10. Refer to [Table 1](#), page 10.

STATIC ELECTRICAL CHARACTERISTICS (continued)

Characteristics noted under conditions $4.75\text{ V} \leq V_{IO} \leq 5.25\text{ V}$, $12\text{ V} \leq V_{B+} \leq 32\text{ V}$, 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
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MODE TERMINALS OPERATING VOLTAGES

MODE Control Terminals Low Voltage $T_J = 0^\circ\text{C}$ to TBD $^\circ\text{C}$, $V_{B+} = 12\text{ V}$ to 32 V	$V_{IL}(\text{MODEn})$	–	–	0.825	V
MODE Control Terminals High Voltage $T_J = 0^\circ\text{C}$ to TBD $^\circ\text{C}$, $V_{B+} = 12\text{ V}$ to 32 V	$V_{IH}(\text{MODEn})$	2.6	–	–	V
MODE Control Terminals Voltage with Input Floating $T_J = 0^\circ\text{C}$ to TBD $^\circ\text{C}$, $V_{B+} = 12\text{ V}$ to 14 V $T_J = 0^\circ\text{C}$ to TBD $^\circ\text{C}$, $V_{B+} = 14\text{ V}$ to 32 V	$V_{\text{MODE}}(\text{FLOAT})$	7.0 8.0	– –	12 13.2	V

SUPERVISOR CIRCUITRY

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	$V_{B+}(\text{ASSERT})$	2.0	–	–	V
$\overline{\text{RST}}$ Low Voltage $V_{B+} = 2.0\text{ V}$, $I_{\overline{\text{RST}}} \leq 5.0\text{ mA}$	V_{OL}	–	–	0.4	V
$\overline{\text{RST}}$ V_{IO} Threshold V_{IO} Rising V_{IO} Falling	V_{IOt+} V_{IOt-}	– $V_{IO}(\text{NOM})$ – 225 mV	– –	$V_{IO}(\text{NOM})$ – 80 mV –	V
$\overline{\text{RST}}$ Hysteresis for V_{IO}	$V_{\text{HYS}V_{IO}}$	10	–	100	mV
$\overline{\text{RST}}$ V_{CORE} Threshold V_{CORE} Rising V_{CORE} Falling	$V_{\text{CORE}t+}$ $V_{\text{CORE}t-}$	– $V_{\text{CORE}}(\text{NOM})$ – 225 mV	– –	$V_{\text{CORE}}(\text{NOM})$ – 80 mV –	V
$\overline{\text{RST}}$ Hysteresis for V_{CORE} $V_{B+} = 12\text{ V}$ to 32 V	$V_{\text{HYS CORE}}$	10	–	100	mV
$V_{\text{CORE}} - V_{IO}$ for V_{CORE} Shutdown $V_{B+} = 12\text{ V}$ to 32 V	$V_{\text{CORE}}(\text{SHUTDOWN})$	–	–	TBD	V
Thermal Shutdown Temperature T_J Rising	$T_J(\text{TSD})$	170	–	–	$^\circ\text{C}$
Overtemperature Hysteresis	$T_J(\text{HYSTERESIS})$	20	–	TBD	$^\circ\text{C}$

V_b CHARGE PUMP

Boost Voltage (Note 11) $V_{B+} = 12\text{ V}$ to 32 V , $I_{Vb} = 0.5\text{ mA}$	V_b	$V_{B+} + 10\text{ V}$	–	$V_{B+} + 12\text{ V}$	V
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Notes

11. Bulk capacitor ESR $\leq 10\ \Omega$.

DYNAMIC ELECTRICAL CHARACTERISTICS

Characteristics noted under conditions $4.75\text{ V} \leq V_{IO} \leq 5.25\text{ V}$, $12\text{ V} \leq V_{B+} \leq 32\text{ V}$, 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
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V_{IO} SWITCHING REGULATOR

Duty Cycle	D	45	—	55	%
Switching Rise and Fall Time Load Resistance = $100\ \Omega$, $V_{B+} = 30\text{ V}$	t_r, t_f	25	—	—	ns
Switching Rise and Fall Time Load Resistance = $100\ \Omega$, $V_{B+} = 30\text{ V}$	$t_r + t_f$	—	—	50	ns

SUPERVISOR CIRCUITRY

$\overline{\text{RST}}$ Delay $C_{\text{delay}} = 0.1\ \mu\text{F}$	t_{delay}	48	—	82	ms
$\overline{\text{RST}}$ Filter Time $V_{B+} = 9.0\text{ V}$	t_{filter}	1.0	—	6.0	μs
$\overline{\text{RST}}$ Fall Time $C_L = 100\text{ pF}$, $R_{\text{PULLUP}} = 4.7\text{ k}\Omega$, 90% to 10%	t_f	—	—	125	ns
External Low (Note 12) $V_{IO} = 5.0\text{ V}$	t_{slpl} (Note 13)	30	—	—	ns
$\overline{\text{RST}}$ Recovery Time Before Next $\overline{\text{RST}}$ Input (Note 12) $V_{IO} = 5.0\text{ V}$	t_{phsl}	—	—	10	μs

INTERNAL OSCILLATOR

Charge Pump and V_{IO} Switching Regulator Operating Frequency $V_{B+} = 9.0\text{ V}$ to 32 V	f_{OP}	140	—	260	kHz
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Notes

12. See [Figure 2. RST Timing](#), page 9.
13. t_{slpl} is an input.

Timing Diagram

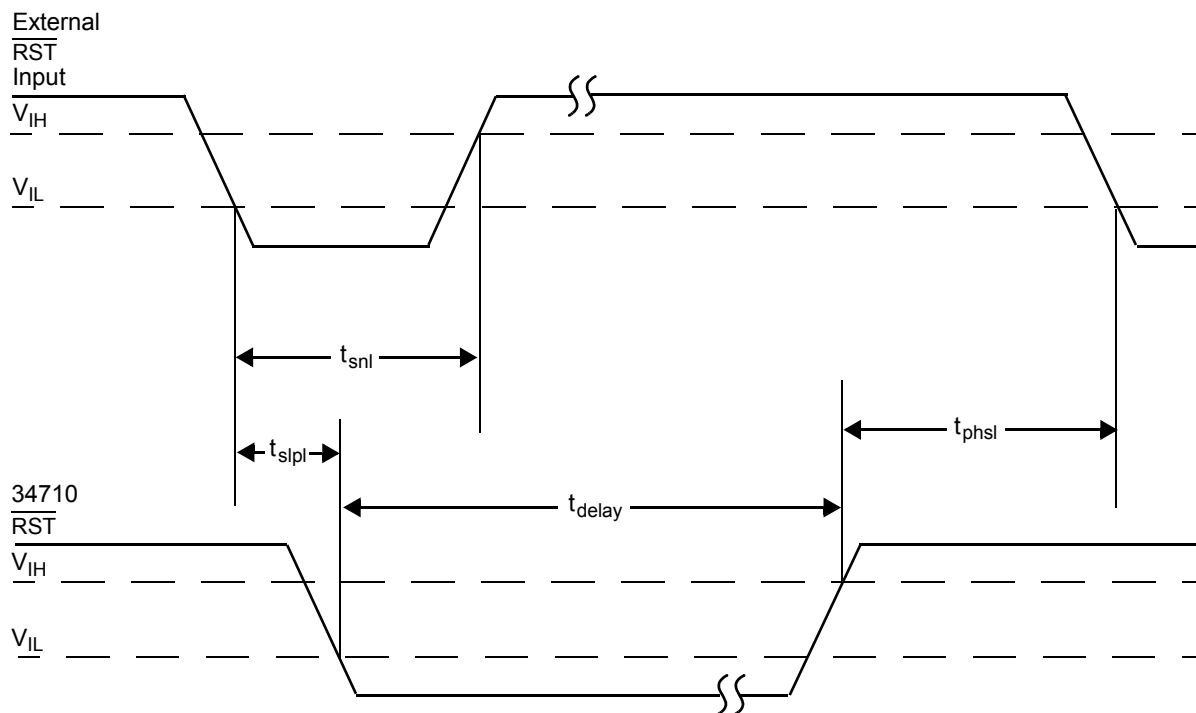


Figure 2. $\overline{\text{RST}}$ Timing

SYSTEM/APPLICATION INFORMATION

INTRODUCTION

$V_{I/O}$ Switching Regulator

The $V_{I/O}$ switching regulator output voltage is determined by the MODE digital input terminals. The 34710's MODE[2:0] select the output voltage (Table 1). For example, if MODE[2:0] = 0, 0, 0, then $V_{I/O}$ = 5.0 V; if MODE[2:0] = Open, Open, Open, then $V_{I/O}$ = 3.3 V. The MODE0 terminal controls the output voltage of both regulators.

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

V_{CORE} Linear Regulator

The V_{CORE} linear regulator can produce a +3.3 V, 2.5 V, 1.8 V, or 1.5 V output voltage at 500 mA. The input to the V_{CORE} regulator is a terminal that may be connected to the $V_{I/O}$ regulator output. The minimum input voltage must be $V_{CORE}(NOM) + 0.8$ V.

The MODE[2:0] terminals select the output voltage as depicted in Table 1.

Table 1. $V_{I/O}$ and $V_{CORE}(NOM)$ Regulator Output Voltage Selection

MODE2	MODE1	MODE0	$V_{I/O}$ (V)	$V_{CORE}(NOM)$ (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.

SUPERVISORY AND MISCELLANEOUS FUNCTIONS

Introduction

The supervisor circuitry provides control of the \overline{RST} line, an open drain signal, based on system operating conditions monitored by the 34710. $V_{I/O}$, V_{CORE} , V_{B+} , and thermal shutdown (TSD) detectors in various parts of the chip are monitored for error conditions. Because other devices in the system may trigger a reset, the \overline{RST} line itself is also monitored, but the supervisor circuitry controls all reset timing, including externally generated resets. Driving the \overline{RST} line low causes the system to be held in the reset state. $V_{I/O}$, V_{CORE} , V_{B+} , and thermal shutdown have both positive- and negative-going thresholds.

The supervisor circuitry also ensures that the power supplies sequence properly. Specifically, that $V_{I/O}$ is never less than TBD V below V_{CORE} . This means that $V_{CORE} - V_{I/O}$ will be clamped at 0.5 V, and that the V_{CORE} regulator operation will be suppressed during startup and shutdown to ensure that $V_{CORE} - V_{I/O} = TBD$ V.

Static Operating Specifications

The \overline{RST} output is an I/O device with an open drain output driver with a pullup and a CMOS digital input gate (Figure 3). This I/O structure allows wired OR connection to the MCU's \overline{RST} I/O terminal, as well as allowing the MCU to initiate a reset cycle by driving its \overline{RST} terminal low. When responding to a MCU request for a reset cycle, the 34710 must respond rapidly enough to prevent a glitch. Figure 2, page 9, shows the timing

parameters for responding to an externally applied \overline{RST} signal. The rise time may be relatively slow, depending on the load capacitance, and the internal \overline{RST} input gate must operate reliably (no oscillations during the transition) under these conditions, i.e., the \overline{RST} input can be inhibited for up to $t_{phs1}(MAX)$. Error conditions must be present for a minimum time, t_{filter} , before the 34710 responds to them. Once all error conditions are cleared, \overline{RST} is held low for an additional time of t_{delay} . If any monitored item falls below its negative-going threshold for t_{filter} , 1.0 μs to 6.0 μs , the t_{delay} will be restarted when system operating conditions are met. The trigger for the t_{delay} retriggerable one shot should be $([V_{I/O}(LOW) + V_{CORE}(LOW) + V_{B+}(LOW) + T_J(TSD)] \& t_{filter})$, where t_{filter} is the 1.0 μs to 6.0 μs delay.

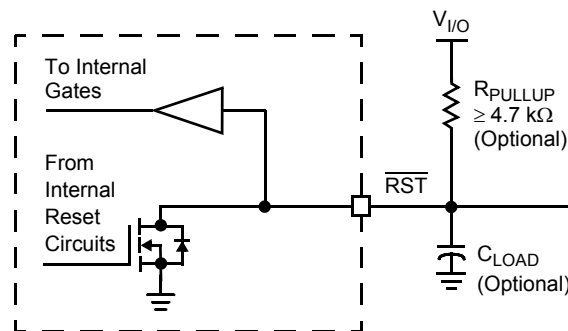


Figure 3. \overline{RST} Terminal Interface

V_b Charge Pump

The high-side MOSFETs in the H-Bridge motor drivers and voltage regulators switch require a gate voltage in excess of V_{B+} , which is provided by the V_b supply. The V_b regulator is a charge pump, switching directly off the V_{B+} supply, and uses an internal oscillator operating at 200 kHz.

Internal Oscillator

The internal oscillator provides timing for the charge pump and switching regulators.

APPLICATIONS

Power Dissipation

The power budget is described in [Table 2](#). The maximum dissipation for this device is 1.0 W continuous.

Table 2. Power Budget

Functional Block	Watt
Bias	0.00
Charge Pump	0.15
Switching Regulator	0.45
Linear Regulator	0.35
Total	0.95

NOTES

NOTES

NOTES

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