



TFT-LCD DC-DC Converters with Operational Amplifiers

MAX1518B

General Description

The MAX1518B includes a high-performance step-up regulator, two linear-regulator controllers, and high-current operational amplifiers for active-matrix, thin-film transistor (TFT), liquid-crystal displays (LCDs). Also included is a logic-controlled, high-voltage switch with adjustable delay.

The step-up DC-DC converter provides the regulated supply voltage for the panel source driver ICs. The converter is a high-frequency (1.2MHz) current-mode regulator with an integrated 14V n-channel MOSFET that allows the use of ultra-small inductors and ceramic capacitors. It provides fast transient response to pulsed loads while achieving efficiencies over 85%.

The gate-on and gate-off linear-regulator controllers provide regulated TFT gate-on and gate-off supplies using external charge pumps attached to the switching node. The MAX1518B includes five high-performance operational amplifiers. These amplifiers are designed to drive the LCD backplane (VCOM) and/or the gamma-correction divider string. The devices feature high output current ($\pm 150\text{mA}$), fast slew rate ($13\text{V}/\mu\text{s}$), wide bandwidth (12MHz), and rail-to-rail inputs and outputs.

The MAX1518B is available in a 32-pin thin QFN package with a maximum thickness of 0.8mm for ultra-thin LCD panels.

Applications

- Notebook Computer Displays
- LCD Monitor Panels
- Automotive Displays

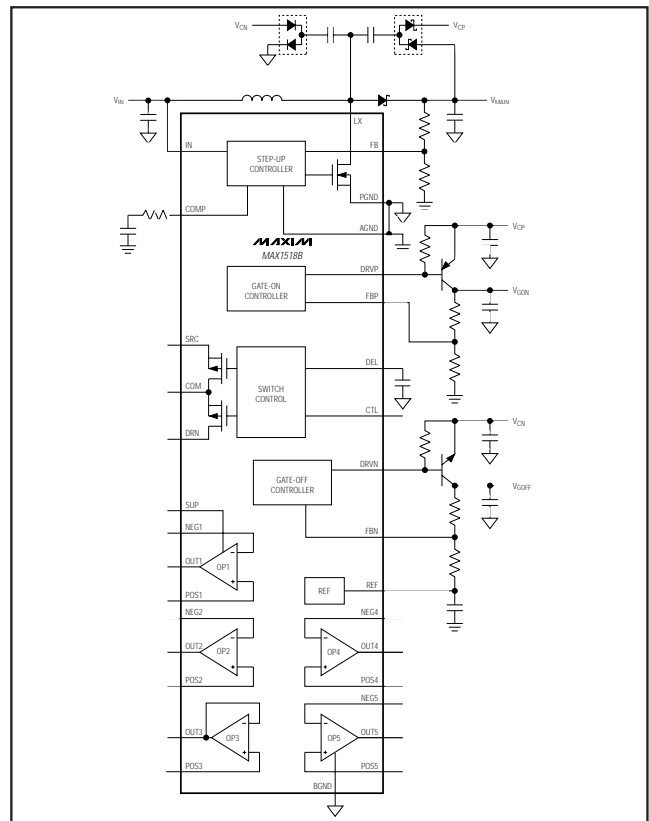
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX1518BETJ	-40°C to +100°C	32 Thin QFN 5mm x 5mm

Features

- ◆ 2.6V to 6.5V Input Supply Range
- ◆ 1.2MHz Current-Mode Step-Up Regulator
 - Fast Transient Response to Pulsed Load
 - High-Accuracy Output Voltage (1.5%)
 - Built-In 14V, 2.4A, 0.16 μF n-Channel MOSFET
 - High Efficiency (90%)
- ◆ Linear-Regulator Controllers for V_{GON} and V_{GOFF}
- ◆ High-Performance Operational Amplifiers
 - $\pm 150\text{mA}$ Output Short-Circuit Current
 - 13V/ μs Slew Rate
 - 12MHz, -3dB Bandwidth
 - Rail-to-Rail Inputs/Outputs
- ◆ Logic-Controlled, High-Voltage Switch with Adjustable Delay
- ◆ Timer-Delay Fault Latch for All Regulator Outputs
- ◆ Thermal-Overload Protection
- ◆ 0.6mA Quiescent Current

Minimal Operating Circuit



Pin Configuration appears at end of data sheet.



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ABSOLUTE MAXIMUM RATINGS

IN, CTL to AGND-0.3V to +7V
 COMP, FB, FBP, FBN, DEL, REF to AGND-0.3V to (V_{IN} + 0.3V)
 PGND, BGND to AGND±0.3V
 LX to PGND-0.3V to +14V
 SUP to AGND-0.3V to +14V
 DRVP, SRC to AGND.....-0.3V to +30V
 POS_, NEG_, OUT_ to AGND-0.3V to (V_{SUP} + 0.3V)
 DRVN to AGND(V_{IN} - 30V) to (V_{IN} + 0.3V)
 DRN to AGND-0.3V to (V_{SRC} + 0.3V)
 DRN to COM.....-30V to +30V

OUT_ Maximum Continuous Output Current±75mA
 LX Switch Maximum Continuous RMS Output Current1.6A
 Continuous Power Dissipation (T_A = +70°C)
 32-Pin Thin QFN (derate 21.2mW/°C above +70°C) ..1702mW
 Operating Temperature Range-40°C to +100°C
 Junction Temperature+150°C
 Storage Temperature Range-65°C to +150°C
 Lead Temperature (soldering, 10s)+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3V, V_{SUP} = 8V, PGND = AGND = BGND = 0, I_{REF} = 25µA, T_A = 0°C to +85°C. Typical values are at T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
IN Supply Range	V _{IN}		2.6		6.5	V	
IN Undervoltage-Lockout Threshold	V _{UVLO}	V _{IN} rising, typical hysteresis = 200mV	2.25	2.5	2.7	V	
IN Quiescent Current	I _{IN}	V _{FB} = V _{FBP} = 1.4V, V _{FBN} = 0, LX not switching		0.6	0.8	mA	
		V _{FB} = 1.1V, V _{FBP} = 1.4V, V _{FBN} = 0, LX switching		6	11		
Duration to Trigger Fault Condition				200		ms	
REF Output Voltage		-2µA < I _{REF} < 50µA, V _{IN} = 2.6V to 5.5V	1.231	1.250	1.269	V	
Thermal Shutdown		Temperature rising		+160		°C	
		Hysteresis		15			
MAIN STEP-UP REGULATOR							
Output Voltage Range	V _{MAIN}		V _{IN}		13	V	
Operating Frequency	f _{OSC}		1020	1200	1380	kHz	
Oscillator Maximum Duty Cycle			84	87	90	%	
FB Regulation Voltage	V _{FB}	No load	T _A = +25°C to +85°C	1.221	1.233	1.245	V
			T _A = 0°C to +85°C	1.218	1.233	1.247	
FB Fault Trip Level		V _{FB} falling	1.12	1.16	1.19	V	
FB Load Regulation		0 < I _{MAIN} < full load, transient only		-1.6		%	
FB Line Regulation		V _{IN} = 2.6V to 5.5V		+0.04	±0.15	%/V	
FB Input Bias Current		V _{FB} = 1.4V	-40		+40	nA	
FB Transconductance		ΔI _{COMP} = 5µA	75	160	280	µS	
FB Voltage Gain		FB to COMP		600		V/V	

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ELECTRICAL CHARACTERISTICS (continued)

($V_{IN} = 3V$, $V_{SUP} = 8V$, $PGND = AGND = BGND = 0$, $I_{REF} = 25\mu A$, $T_A = 0^\circ C$ to $+85^\circ C$. Typical values are at $T_A = +25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
LX On-Resistance	$R_{LX(ON)}$			160	250	$m\Omega$
LX Leakage Current	I_{LX}	$V_{LX} = 13V$		0.02	40	μA
LX Current Limit	I_{LIM}	$V_{FB} = 1V$, duty cycle = 65%	2.5	3.0	3.5	A
Current-Sense Transconductance			3.0	3.8	5	S
Soft-Start Period	t _{SS}			14		ms
Soft-Start Step Size				$I_{LIM} / 8$		A
OPERATIONAL AMPLIFIERS						
SUP Supply Range	V_{SUP}		4.5		13.0	V
SUP Supply Current	I_{SUP}	Buffer configuration, $V_{POS_} = 4V$, no load		2.4	3.8	mA
Input Offset Voltage	V_{OS}	$(V_{NEG_}, V_{POS_}, V_{OUT_}) \cong V_{SUP} / 2$, $T_A = +25^\circ C$		0	12	mV
Input Bias Current	I_{BIAS}	$(V_{NEG_}, V_{POS_}, V_{OUT_}) \cong V_{SUP} / 2$		+1	± 50	nA
Input Common-Mode Range	V_{CM}		0		V_{SUP}	V
Common-Mode Rejection Ratio	CMRR	$0 \leq (V_{NEG_}, V_{POS_}) \leq V_{SUP}$	45			dB
Open-Loop Gain				125		dB
Output Voltage Swing, High	V_{OH}	$I_{OUT_} = 100\mu A$	$V_{SUP} - 15$	$V_{SUP} - 3$		mV
		$I_{OUT_} = 5mA$	$V_{SUP} - 150$	$V_{SUP} - 80$		
Output Voltage Swing, Low	V_{OL}	$I_{OUT_} = -100\mu A$		2	15	mV
		$I_{OUT_} = -5mA$		80	150	
Short-Circuit Current		To $V_{SUP} / 2$, source or sink	50	150		mA
Output Source and Sink Current		$(V_{NEG_}, V_{POS_}, V_{OUT_}) \cong V_{SUP} / 2$, $ \Delta V_{OS} < 10mV$	40			mA
Power-Supply Rejection Ratio	PSRR	DC, $6V \leq V_{SUP} \leq 13V$, $(V_{NEG_}, V_{POS_}) \cong V_{SUP} / 2$	60			dB
Slew Rate				13		V/ μs
-3dB Bandwidth		$R_L = 10k\Omega$, $C_L = 10pF$, buffer configuration		12		MHz
Gain-Bandwidth Product	GBW	Buffer configuration		8		MHz
GATE-ON LINEAR-REGULATOR CONTROLLER						
FBP Regulation Voltage	V_{FBP}	$I_{DRVP} = 100\mu A$	1.231	1.250	1.269	V
FBP Fault Trip Level		V_{FBP} falling	0.96	1.00	1.04	V
FBP Input Bias Current	I_{FBP}	$V_{FBP} = 1.4V$	-50		+50	nA
FBP Effective Load-Regulation Error (Transconductance)		$V_{DRVP} = 10V$, $I_{DRVP} = 50\mu A$ to 1mA		-0.7	-1.5	%

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ELECTRICAL CHARACTERISTICS (continued)

($V_{IN} = 3V$, $V_{SUP} = 8V$, $PGND = AGND = BGND = 0$, $I_{REF} = 25\mu A$, $T_A = 0^\circ C$ to $+85^\circ C$. Typical values are at $T_A = +25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
FBP Line (IN) Regulation Error		$I_{DRVP} = 100\mu A$, $2.6V < V_{IN} < 5.5V$		± 1.5	± 5	mV
DRVP Sink Current	I_{DRVP}	$V_{FBP} = 1.1V$, $V_{DRVP} = 10V$	1	5		mA
DRVP Off-Leakage Current		$V_{FBP} = 1.4V$, $V_{DRVP} = 28V$		0.01	10	μA
Soft-Start Period	t_{SS}			14		ms
Soft-Start Step Size				$V_{REF} / 128$		V
GATE-OFF LINEAR-REGULATOR CONTROLLER						
FBN Regulation Voltage	V_{FBN}	$I_{DRVN} = 100\mu A$	235	250	265	mV
FBN Fault Trip Level		V_{FBN} rising	370	420	470	mV
FBN Input Bias Current	I_{FBN}	$V_{FBN} = 0$	-50		+50	nA
FBN Effective Load-Regulation Error (Transconductance)		$V_{DRVN} = -10V$, $I_{DRVN} = 50\mu A$ to $1mA$		11	25	mV
FBN Line (IN) Regulation Error		$I_{DRVN} = 0.1mA$, $2.6V < V_{IN} < 5.5V$		± 0.7	± 5	mV
DRVN Source Current	I_{DRVN}	$V_{FBN} = 500mV$, $V_{DRVN} = -10V$	1	4		mA
DRVN Off-Leakage Current		$V_{FBN} = 0V$, $V_{DRVN} = -25V$		-0.01	-10	μA
Soft-Start Period	t_{SS}			14		ms
Soft-Start Step Size				$V_{REF} / 128$		V
POSITIVE GATE-DRIVER TIMING AND CONTROL SWITCHES						
DEL Capacitor Charge Current		During startup, $V_{DEL} = 1V$	4	5	6	μA
DEL Turn-On Threshold	$V_{TH(DEL)}$		1.19	1.25	1.31	V
DEL Discharge Switch On-Resistance		During UVLO, $V_{IN} = 2.2V$		20		Ω
CTL Input Low Voltage		$V_{IN} = 2.6V$ to $5.5V$			0.6	V
CTL Input High Voltage		$V_{IN} = 2.6V$ to $5.5V$	2			V
CTL Input Leakage Current		CTL = AGND or IN	-1		+1	μA
CTL-to-SRC Propagation Delay				100		ns
SRC Input Voltage Range					28	V
SRC Input Current	I_{SRC}	$V_{DEL} = 1.5V$, CTL = IN		50	100	μA
		$V_{DEL} = 1.5V$, CTL = AGND		15	30	
SRC to COM Switch On-Resistance	$R_{SRC(ON)}$	$V_{DEL} = 1.5V$, CTL = IN		6	12	Ω
DRN to COM Switch On-Resistance	$R_{DRN(ON)}$	$V_{DEL} = 1.5V$, CTL = AGND		35	70	Ω

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ELECTRICAL CHARACTERISTICS

($V_{IN} = 3V$, $V_{SUP} = 8V$, $PGND = AGND = BGND = 0$, $I_{REF} = 25\mu A$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	MAX	UNITS
IN Supply Range	V_{IN}		2.6	5.5	V
IN Undervoltage-Lockout Threshold	V_{UVLO}	V_{IN} rising, typical hysteresis = 150mV	2.25	2.715	V
IN Quiescent Current	I_{IN}	$V_{FB} = V_{FBP} = 1.4V$, $V_{FBN} = 0$, LX not switching		0.8	mA
		$V_{FB} = 1.1V$, $V_{FBP} = 1.4V$, $V_{FBN} = 0$, LX switching		11	
REF Output Voltage		$-2\mu A < I_{REF} < 50\mu A$, $V_{IN} = 2.6V$ to $5.5V$	1.222	1.269	V
MAIN STEP-UP REGULATOR					
Output Voltage Range	V_{MAIN}		V_{IN}	13	V
Operating Frequency	f_{OSC}		1020	1380	kHz
FB Regulation Voltage	V_{FB}	No load	1.212	1.250	V
FB Line Regulation		$V_{IN} = 2.6V$ to $5.5V$		± 0.15	%/V
FB Input Bias Current		$V_{FB} = 1.4V$	-40	+40	nA
FB Transconductance		$\Delta I_{COMP} = 5\mu A$	75	300	μS
LX On-Resistance	$R_{LX(ON)}$			250	$m\Omega$
LX Current Limit	I_{LIM}	$V_{FB} = 1V$, duty cycle = 65%	2.5	3.5	A
OPERATIONAL AMPLIFIERS					
SUP Supply Range	V_{SUP}		4.5	13.0	V
SUP Supply Current	I_{SUP}	Buffer configuration, $V_{POS_} = 4V$, no load	MAX1518	3.8	mA
Input Offset Voltage	V_{OS}	$(V_{NEG_}, V_{POS_}, V_{OUT_}) \cong V_{SUP} / 2$		12	mV
Input Common-Mode Range	V_{CM}		0	V_{SUP}	V
Output Voltage Swing, High	V_{OH}	$I_{OUT_} = 100\mu A$		$V_{SUP} - 15$	mV
		$I_{OUT_} = 5mA$		$V_{SUP} - 150$	
Output Voltage Swing, Low	V_{OL}	$I_{OUT_} = -100\mu A$		15	mV
		$I_{OUT_} = -5mA$		150	
Short-Circuit Current		$To V_{SUP} / 2$	Source	50	mA
			Sink	50	
Output Source-and-Sink Current		$(V_{NEG_}, V_{POS_}, V_{OUT_}) \cong V_{SUP} / 2$, $ \Delta V_{OS} < 10mV$	40		mA
GATE-ON LINEAR-REGULATOR CONTROLLER					
FBP Regulation Voltage	V_{FBP}	$I_{DRVP} = 100\mu A$	1.218	1.269	V

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ELECTRICAL CHARACTERISTICS (continued)

($V_{IN} = 3V$, $V_{SUP} = 8V$, $PGND = AGND = BGND = 0$, $I_{REF} = 25\mu A$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	MAX	UNITS
FBP Effective Load-Regulation Error (Transconductance)		$V_{DRV} = 10V$, $I_{DRV} = 50\mu A$ to $1mA$		-2	%
FBP Line (IN) Regulation Error		$I_{DRV} = 100\mu A$, $2.6V < V_{IN} < 5.5V$		5	mV
DRV Sink Current	I_{DRV}	$V_{FB} = 1.1V$, $V_{DRV} = 10V$	1		mA
GATE-OFF LINEAR-REGULATOR CONTROLLER					
FBN Regulation Voltage	V_{FBN}	$I_{DRV} = 100\mu A$	235	265	mV
FBN Effective Load-Regulation Error (Transconductance)		$V_{DRV} = -10V$, $I_{DRV} = 50\mu A$ to $1mA$		25	mV
FBN Line (IN) Regulation Error		$I_{DRV} = 0.1mA$, $2.6V < V_{IN} < 5.5V$		5	mV
DRVN Source Current	I_{DRVN}	$V_{FB} = 500mV$, $V_{DRVN} = -10V$	1		mA
POSITIVE GATE-DRIVER TIMING AND CONTROL SWITCHES					
DEL Capacitor Charge Current		During startup, $V_{DEL} = 1V$	4	6	μA
DEL Turn-On Threshold	$V_{TH(DEL)}$		1.19	1.31	V
CTL Input Low Voltage		$V_{IN} = 2.6V$ to $5.5V$		0.6	V
CTL Input High Voltage		$V_{IN} = 2.6V$ to $5.5V$	2		V
SRC Input Voltage Range				28	V
SRC Input Current	I_{SRC}	$V_{DEL} = 1.5V$, CTL = IN		100	μA
		$V_{DEL} = 1.5V$, CTL = AGND		30	
SRC-to-COM Switch On-Resistance	$R_{SRC(ON)}$	$V_{DEL} = 1.5V$, CTL = IN		12	Ω
DRN-to-COM Switch On-Resistance	$R_{DRN(ON)}$	$V_{DEL} = 1.5V$, CTL = AGND		70	Ω

Note 1: Specifications to $-40^{\circ}C$ are guaranteed by design, not production tested.