MAX25220/MAX25221 Automotive 4-Channel TFT-LCD Power Supply with VCOM Buffer

General Description

The MAX25220/MAX25221 is a 4-channel TFT-LCD power IC that provides symmetrical positive AVDD and negative NAVDD supplies as well as VG_{ON} and VG_{OFF} gate supplies. In addition, a VCOM buffer with output voltage range above and below ground and a temperature measurement block are integrated (MAX25221).

The device contains non-volatile memory so that the values of all outputs can be calibrated for the lifetime of the device (maximum five times).

Programming is carried out using the built-in I^2C interface, which can also be used to read back diagnostic information. A stand-alone mode is also available.

The temperature sensor interface block measures the temperature optionally allowing the VCOM output voltage to be adjusted depending on the measured temperature.

The MAX25220/MAX25221 is available in a TQFN package and operates in the -40 to 125°C temperature range.

Applications

- Infotainment Displays
- Central Information Displays
- Instrument Clusters

Benefits and Features

- High Integration
  - Synchronous Boost Provides AVDD of 4.2V to 10.5V at up to 200mA
  - NAVDD Inverter Output at up to -200mA
  - 15mA VG_{ON} Output (7.6V to 20.2V) from 3x Regulated Charge Pump
  - VG_{OFF} (-18.2V to -5.6V) from Regulated Charge Pump at up to -15mA (charge-pump doubler)
  - Controlled Sequencing during Power-On and Power-Off of All Rails
  - VCOM Output Range +1V to -2.49V in 6.83mV Steps (MAX25221)
  - NTC Input for Temperature Measurement/ Compensation (MAX25221)
- Low EMI
  - 420kHz/2.1MHz Switching Frequency with Spread Spectrum
- I^2C Control/Diagnostic Interface with FLTB (Interrupt) Output
  - UV diagnostics on All Outputs
- Versatile
  - Non-Volatile Output Voltage Settings on AVDD/ NAVDD, VG_{ON}, VG_{OFF}, VCOM, and Sequencing
  - Supports Stand-Alone Operation Mode after Programming
  - Compact 5mm x 5mm TQFN32 Package
- AECQ100 Grade 1

Ordering Information appears at end of datasheet.

19-100803; Rev 1; 6/20

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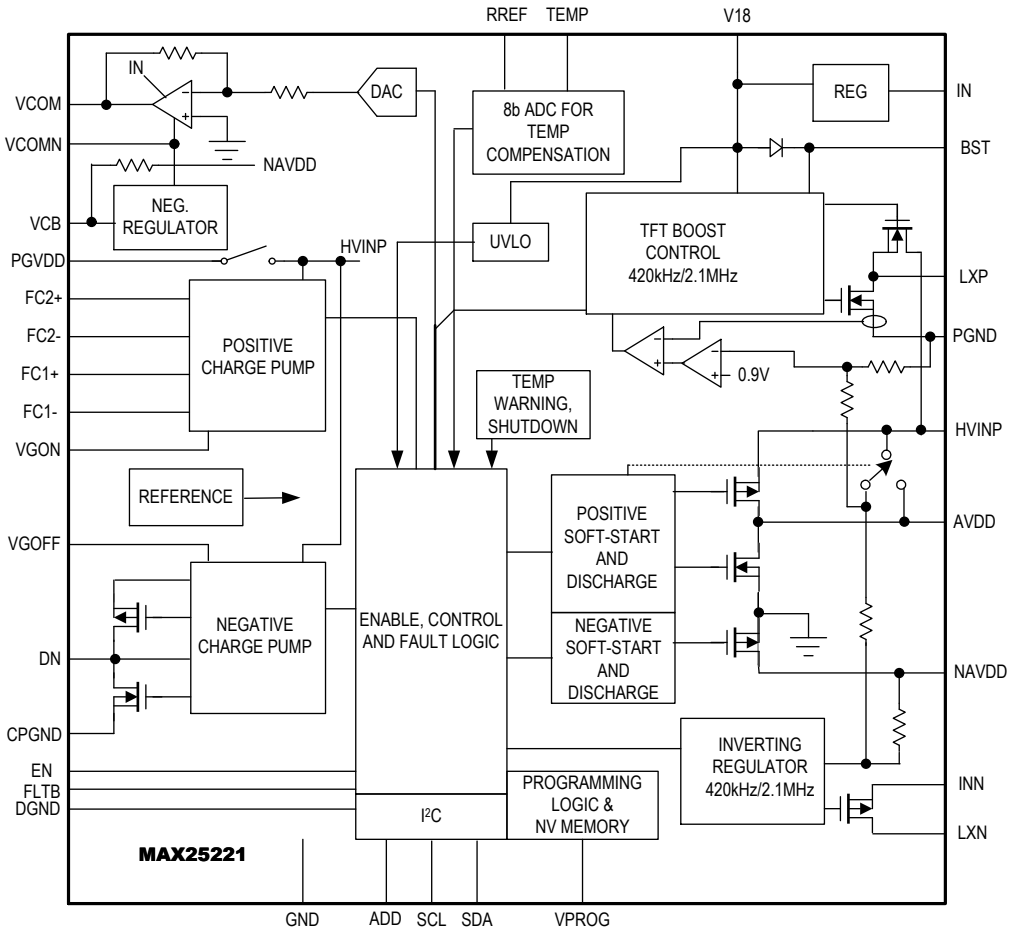
Simplified Block Diagram



LIST OF FIGURES

LIST OF TABLES

Absolute Maximum Ratings

IN, INN to GND ..... -0.3V to +6V
IN to INN ..... -0.3V to +0.3V
V18 to GND ..... -0.3V to +2.2V
HVINP to GND ..... -0.3V to 16V
LXP, AVDD to GND ..... -0.3V to HVINP + 0.3V
BST to GND ..... -0.3V to +16V
BST to LXP ..... -0.3V to +2.2V
LXN to INN ..... -22V to +0.3V
PGND, CPGND, DGND to GND ..... -0.3V to +0.3V
VCB to GND ..... V18 - 22V to V18 + 0.3V
VG_{OFF}, NAVDD to GND ..... IN - 22V to IN + 0.3V
VCOM to GND ..... VCOMN - 0.3V to IN + 0.3V
VCOMN to GND ..... V18 - 6V to V18 + 0.3V
PGVDD, FC1-, FC2-, DN to GND ..... -0.3V to HVINP + 0.3V
FC1+ to GND ..... -0.3V to PGVDD + 0.3V
FC2+ TO FC1+ ..... -0.3V to +22V
VG_{ON} to FC2+ ..... -0.3V to +22V
FC2+, VG_{ON} to GND ..... -0.3V to +24V
EN, FLTB, SCL, SDA to GND ..... -0.3V to +6V
ADD, TEMP, R_{REF} to GND ..... -0.3V to V18 + 0.3V
V_{PROG} to GND ..... -0.3V to +14V
Continuous Power Dissipation (Multilayer Board) (T_A = +70ºC, derate 21.3mW/ºC above +70ºC) 2222mW
Operating Temperature Range ..... -40°C to 125°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.

Package Information

TQFN

Package Code	T3255+6C
Outline Number	21-0140
Land Pattern Number	90-0603
Thermal Resistance, Single-Layer Board:	
Junction to Ambient (θ_{JA})	47°C/W
Junction to Case (θ_{JC})	3°C/W
Thermal Resistance, Four-Layer Board:	
Junction to Ambient (θ_{JA})	36°C/W
Junction to Case (θ_{JC})	3°C/W

TQFN-SW

Package Code	T3255Y+6C
Outline Number	21-100041
Land Pattern Number	90-100066
Thermal Resistance, Single-Layer Board:	
Junction to Ambient (θ_{JA})	36°C/W
Junction to Case (θ_{JC})	3°C/W
Thermal Resistance, Four-Layer Board:	
Junction to Ambient (θ_{JA})	47°C/W
Junction to Case (θ_{JC})	3°C/W

For the latest package outline information and land patterns (footprints), go to *www.maximintegrated.com/packages*. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to *www.maximintegrated.com/thermal-tutorial*.

Electrical Characteristics

(V_{IN} = 3.3V, V_{INN} = 3.3V, Limits are 100% guaranteed between T_A = -40°C and T_A = +125°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT SUPPLY						
IN Voltage Range			2.65		5.5	V
IN UVLO Threshold	IN_UVLO_R	Rising	2.4	2.5	2.57	V
IN UVLO Hysteresis	IN_UVLO_HYS			100		mV
IN Shutdown Current	I_{IN_SHDN}	EN = GND, V_{IN} = 3.3V, T_A = 25°C		7	12	µA
IN Quiescent Current	I_{IN_Q}	V_{EN} = V_{IN} = 3.3V, no switching.		1.5	2.5	mA
V18 REGULATOR						
V18 Output Voltage			1.72	1.8	1.88	V
V18 Current Limit			60			mA
V18 Undervoltage Lockout		V18 rising	1.6	1.65	1.7	V
V18 Undervoltage Hysteresis				150		mV
OSCILLATOR						
Operating Frequency	f_{BOOSTH}	f_{SW} bit = 0, dither disabled. Switching frequency for boost, inverter, and charge pumps.	1950	2100	2250	kHz
	f_{BOOSTL}	f_{SW} bit = 1, dither disabled. Switching frequency for boost, inverter, and charge pumps.	385	420	455	
Frequency Dither	f_{BOOSTD}			±6		%
BOOST REGULATOR						
HVINP Output Voltage Range	V_{HVINP}		V_{IN} + 1		10.5	V
AVDD Output Voltage Range			4.2		10.5	V
AVDD Adjustment Step Size				0.1		V
AVDD Output Regulation	V_{AVDD}	avdd[5:0] = 0x1A, full load current and input voltage range	6.664	6.8	6.936	V
Oscillator Maximum Duty Cycle		420kHz switching frequency	87	88.5	90	%
		2.1MHz switching frequency	84	87	90	
Low-Side Switch On-Resistance	LXP_RON_LS	I_{LXP} = 0.1A		0.1	0.2	Ω
Synchronous Rectifier On-Resistance				0.1	0.2	Ω
Synchronous Rectifier Zero-Crossing Threshold	ZX_TH			70		mA
LXP Leakage Current	LXP_L_LEAK	V_{EN} = 0V, V_{LXP} = 10.5V			20	µA
LXP Current Limit	I_{LIMPH}	Duty cycle = 50%	1.7	2	2.3	A

Electrical Characteristics (continued)

(V_{IN} = 3.3V, V_{INN} = 3.3V, Limits are 100% guaranteed between T_A = -40°C and T_A = +125°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Soft-Start Period	t_{BOOST_SS}	Current-limit ramp		5		ms
INVERTING REGULATOR						
Oscillator Maximum Duty Cycle		2.1MHz switching frequency	92	95		%
	INV_MAXDC	420kHz switching frequency	88	90		
V_{AVDD} + V_{NAVDD} Regulation Voltage	$V_{NAVDD\_AVDD\_REG}$	V_{INN} = 2.65V to 5.5V, V_{AVDD} = 6.8V, 1mA < I_{NAVDD} < 200mA, I_{AVDD} = same load as NAVDD	-34	0	34	mV
LXN On-Resistance	LXN_RON	INN to LXN, I_{LXN} = 0.1A		0.25	0.5	Ω
LXN Leakage Current	LXN_LEAK	V_{IN} = 3.6V, V_{LXN} = V_{NAVDD} = -6.8V, T_A = +25°C			20	µA
LXN Current Limit	I_{LIMNH}	Duty cycle = 80%	1.55	1.9	2.25	A
Soft-Start Period	t_{INV_SS}	Current-limit ramp		5		ms
NAVDD Discharge Resistance				2		kΩ
POSITIVE CHARGE-PUMP REGULATOR						
VG_{ON} Threshold for Charge-Pump Switching Enable				V_{HVINP}-0.8		V
FC1-, FC2- Switches Current Limit, High-side			90	120		mA
FC1-, FC2- Switches Current Limit, Low-side			72	100		mA
FC1-, FC2- to CPGND On-Resistance				4	6.5	Ω
FC1-, FC2- to HVINP On-Resistance				6	10.5	Ω
FC2+ to PGVDD, FC1+ to FC2+ and VG_{ON} to FC1+ Switches On-Resistance				2.5	4.5	Ω
VG_{ON} Voltage Range, I^2C Mode			7.6		20.2	V
VG_{ON} Adjustment Step Size, I^2C Mode				0.2		V
VG_{ON} Output Voltage	V_{VGON}	vgon[5:0] = 0x16, full load current and V_{HVINP} > 5V, charge-pump tripler	11.7	12	12.3	V
VG_{ON} Discharge Resistance			2.2	3	3.8	kΩ
NEGATIVE CHARGE-PUMP REGULATOR						
DN Current Limit			75	100		mA
VG_{OFF} Voltage Range, I^2C Mode			-18.2		-5.6	V

Electrical Characteristics (continued)

(V_{IN} = 3.3V, V_{INN} = 3.3V, Limits are 100% guaranteed between T_A = -40°C and T_A = +125°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
VG_{OFF} Adjustment Step Size, I^2C Mode				0.2		V
VG_{OFF} Output-Voltage Accuracy		vgoff[5:0] = 0x16, full load current and input voltage range, 420kHz operation.	-10.3	-10	-9.7	V
DN On-Resistance, High-Side				6	10	Ω
DN On-Resistance, Low-Side		I_{DN} = -10mA		3.5	6.5	Ω
VG_{OFF} Discharge Current				1.5		mA
SEQUENCE SWITCHES						
AVDD ON Resistance	R_{ONAVDD}	Between HVINP and AVDD, I_{AVDD} = 200mA		0.5	1	Ω
AVDD Current Limit	$ILIM_{POS}$		300		600	mA
AVDD Discharge Resistance				1.2		kΩ
PGVDD On resistance		(HVINP-PGVDD), I_{PGVDD} = 3mA		6	9	Ω
PGVDD Current Limit		Expires when PGVDD charging is completed	80	100		mA
FAULT PROTECTION						
Fault Timeout		tfault[1:0] = 10		60		ms
Fault Retry Time		tretry[1:0] = 10 or 11		1.9		s
FLTB Output Frequency		Stand-alone mode only	0.88	1	1.12	kHz
FLTB Output Duty Cycle, VG_{ON} or VG_{OFF} Fault		Stand-alone mode only		75		%
FLTB Output Duty Cycle with AVDD, NAVDD or HVINP Fault		Stand-alone mode only		50		%
FLTB Output Duty Cycle, VCOM Fault		Stand-alone mode only		25		%
AVDD Undervoltage Fault Threshold		Relative measurement between HVINP and AVDD	80	85	90	%
AVDD Short-Circuit Fault Threshold		Relative measurement between HVINP and AVDD	35	40	45	%
NAVDD Undervoltage Fault Threshold		Measured with respect to AVDD	80	85	90	%
NAVDD Short-Circuit Fault Threshold		Measured with respect to AVDD	35	40	45	%
VG_{ON} Undervoltage Fault Threshold		Of set value	80	85	90	%
VG_{ON} Short-Circuit Fault Threshold		VG_{ON} Falling		V_{HVINP}-1.1		V

Electrical Characteristics (continued)

(V_{IN} = 3.3V, V_{INN} = 3.3V, Limits are 100% guaranteed between T_A = -40°C and T_A = +125°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
VG_{OFF} Undervoltage Fault Threshold		Of set value	80	85	90	%
VG_{OFF} Short-Circuit Fault Threshold			35	40	45	%
Short-Circuit and Overload Fault Delay				10		µs
VCOM BUFFER						
VCOMN Output Voltage		I_{VCOM} = 120mA, V_{NAVDD} = -10.5V		-3.5	-3.2	V
VCB Output Current			5	12	21	mA
VCOM Output Current Limit, Sinking		Dynamic output current, t < t_{FAULT}	120	200	300	mA
VCOM Output Current Limit, Sourcing	$I_{LIMCOMP}$	Dynamic output current, t < t_{FAULT}	120	200	300	mA
VCOM Overcurrent Detection Threshold			60	70	85	of $I_{LIMCOMP}$
VCOM Offset Voltage, Complete Range		V_{VCOM} = -2.49V and V_{VCOM} = +1V, no load	-20		+20	mV
VCOM Offset Voltage, 25°C		T_A = 25°C	-6		+6	mV
VCOM Offset Voltage		VCOM = -0.5V	-10		+10	mV
VCOM Output Voltage Range		Temperature compensation disabled	-2.49		1	V
VCOM DAC Step Size				6.83		mV
VCOM Buffer Slew Rate		C_{VCOM} = 10nF, VCOM from -2.49V to +1V		0.72		V/µs
VCOM Fault Threshold		Deviation from set voltage		±0.25		V
VCOM Fault Detection Filter Time		tfault[1:0] = 10		60		ms
VCOM Discharge Resistance		to GND	9	14	22	kΩ
R_{REF} INPUT						
R_{REF} Input Voltage Range			0		1.25	V
R_{REF} ADC Resolution				4.88		mV
R_{REF} Conversion Rate				128		kHz
TEMP Voltage	V_{TEMP}	I_{TEMP} = 10 to 500µA		625		mV
TEMP Current Mirror Gain		I_{TEMP} = 10 to 500µA		1		µA/µA
Internal Temperature Sensor Voltage		T_A = 25°C		620		mV
R_{REF} DAC Offset				5		mV

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	5/20	Initial release	—
1	6/20	Removed future product notation from MAX25221ATJ/V+ *in Ordering Information*	54
2	6/20	Added *Typical Operating Characteristics*	14, 15