



## Multi-Channel DC-DC Converter for LCD Panel

### General Description

The LP6286 includes a high-efficiency boost regulator, a gate pulse modulator (GPM), a voltage detector, a VCOM buffer, and dual charge pump controller for active matrix TFT LCDs.

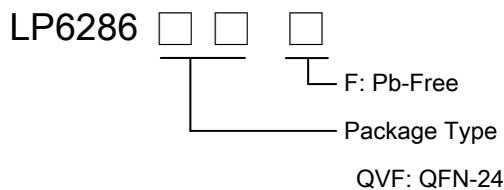
The converter is a high switching frequency current-mode regulator with an integrated N-Channel 0.2Ω MOSFET that allows the use of small inductors and ceramic capacitors.

The OPA can drive the LCD VCOM voltage by Unity-Gain buffer, that features high short-circuit current, fast slew rate and rail-to-rail inputs and outputs.

The charge pump controller provides regulated TFT Gate-On voltage. The regulation of the charge pump is generated by the internal comparator that senses the output voltage and compares it with an internal reference.

Other features include under-voltage protection, short circuit protection, thermal shutdown protection and under-voltage lockout (UVLO). The LP6286 is available in a space saving QFN-24 (0.5mm pitch) package.

### Order Information



### Features

- ◆ Wide  $V_{IN}$  Range: 2.5V to 5.5V
- ◆ 1.2MHz Current-Mode Boost Regulator
  - Fast Transient Response to Pulsed Load
  - Adjustable Output Voltage ( $\pm 1\%$ )
  - Built-In 3A, 0.2Ω N-MOSFET
  - High Efficiency Up to 90%
  - Internal Soft-Start
- ◆ GPM Controller with Adjustable
  - Power-On Delay and Falling Time
  - Adjustable VGHM Delay
- ◆ Low Voltage Detector
  - Programmable Detecting Voltage
  - Open-Drain Reset Output
- ◆ Operation Amplifier for VCOM Buffer
- ◆ VGH and VGL Charge Pump
- ◆ Under-Voltage Protection
- ◆ Over-Temperature Protection
- ◆ Available in QFN-24 (4x4mm)
- ◆ RoHS Compliant and Halogen Free
- ◆ Pb-Free Package

### Applications

- ◆ TFT LCD Panel
- ◆ TFT LCD Monitor

### Marking Information

Device	Marking	Package	Shipping
LP6286	LPS LP6286 YWX	QFN-24	3K/REEL
Y: Y is year code. W: W is week code. X: X is series number.			





### Typical Application Circuit

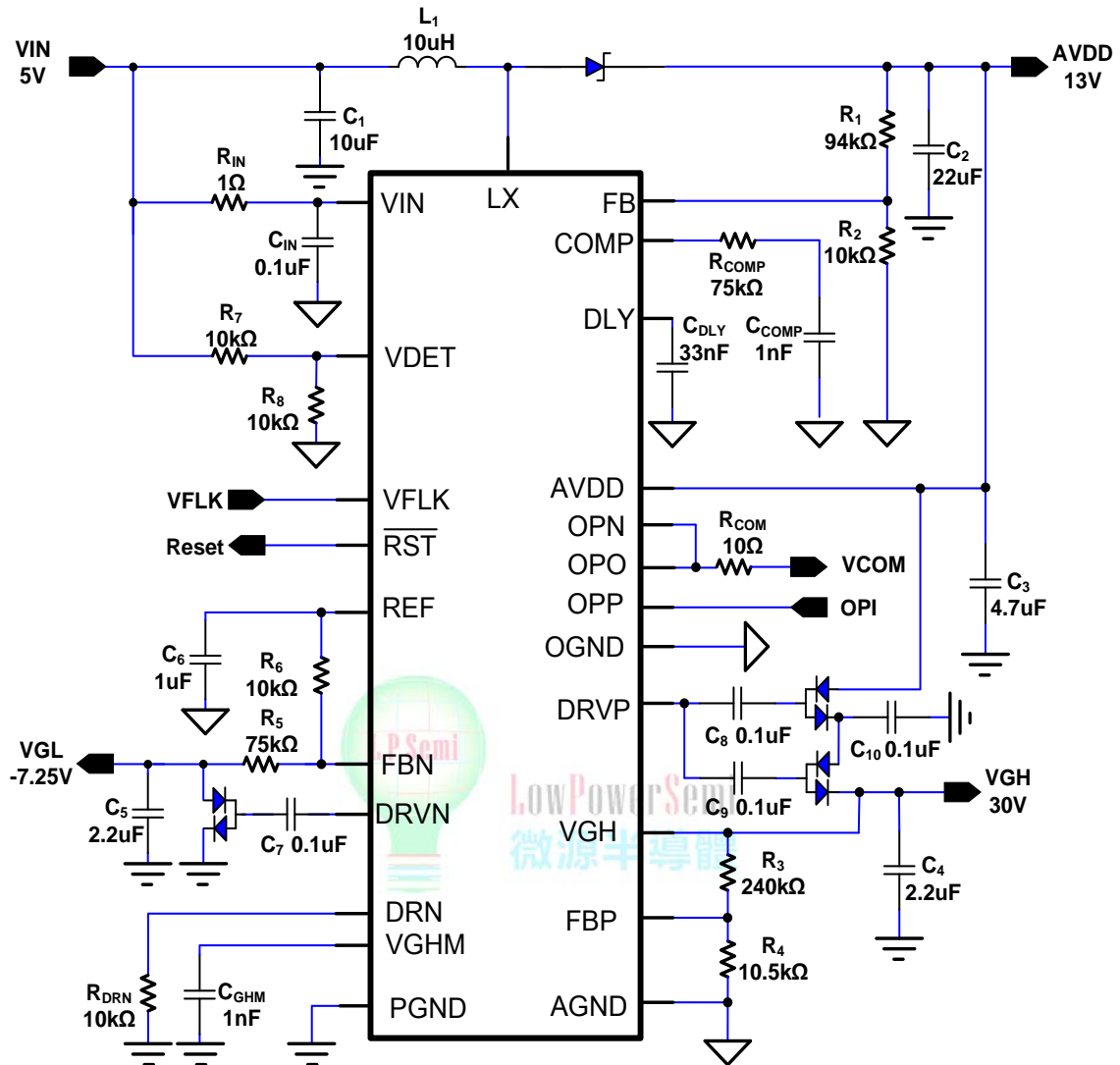


Figure 1. Typical Application Circuit of LP6286



### Pin Configuration

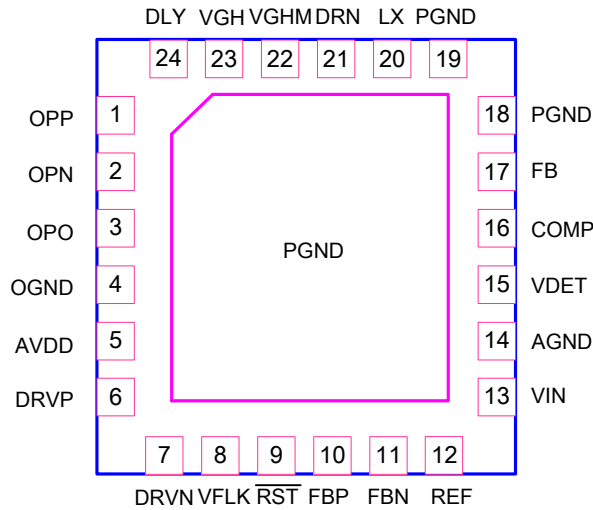


Figure 2. QFN-24 Package (4mm x 4mm) Top View

### Function Block Diagram

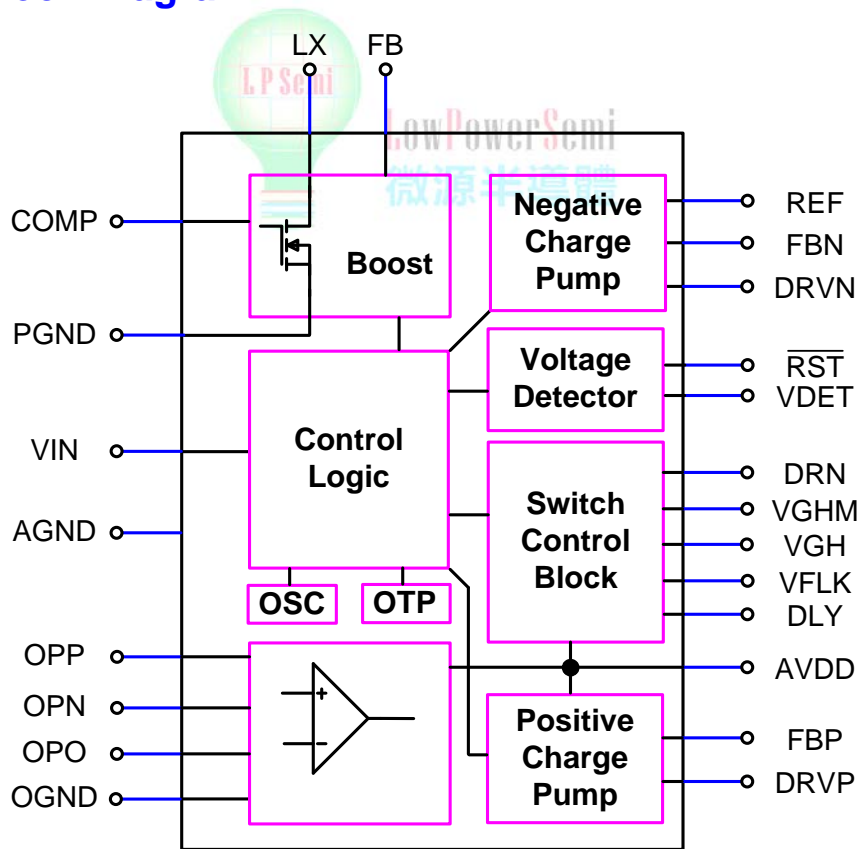


Figure 3. Function Block Diagram



## Functional Pin Description

Pin NO.	Pin Name	Description
1	OPP	OPA Non-Inverting Input.
2	OPN	OPA Inverting Input.
3	OPO	OPA Output.
4	OGND	Ground for OPA. Connect this pin to ground.
5	AVDD	VDD for Source Driver Power. This also supplies the Charge-Pump/OPA power source.
6	DRVVP	VGH Charge-Pump Regulator Driver Output.
7	DRVVN	VGL Charge-Pump Regulator Driver Output.
8	VFLK	VFLK is produced by timing controller for charging or discharging VGHM.
9	$\overline{\text{RST}}$	Open-Drain Output for Reset. Active Low.
10	FBP	VGH Charge-Pump Regulator Feedback Input. Connect to an external resistive voltage divider from the VGH to GND to set the output voltage.
11	FBN	VGL Charge-Pump Regulator Feedback Input. Connect to an external resistive voltage divider from the VGL to REF to set the output voltage.
12	REF	Reference Voltage Output. Connect a ceramic capacitor between REF and GND.
13	VIN	Supply Input. The input voltage range is between 2.5V to 5.5V. Connect a ceramic capacitor between VIN and GND.
14	AGND	Analog GND.
15	VDET	Voltage Detector Input. Connect to an external resistive voltage divider from the VIN to AGND.
16	COMP	Boost Regulator Error Amplifier Compensation Pin.
17	FB	Boost Regulator Feedback Input. Connect to an external resistive voltage divider from the output to FB to set the output voltage.
18	PGND	Power Ground.
19	PGND	Power Ground.
20	LX	Boost Regulator Switching Node. Connect the inductor and the schottky diode to LX.
21	DRN	GPM Discharge Pin. Connect a resistor between DRN and GND.
22	VGHM	GPM Output.
23	VGH	GPM Input.
24	DLY	VGHM Delay Discharge Time. Connect a capacitor between DLY and GND.
EP		Exposed pad. Connect this pin to other gnd pin.



## Absolute Maximum Ratings <sup>Note 1</sup>

◇ VIN, RST to GND	-----	-0.3V to +7V
◇ AVDD, LX to GND	-----	-0.3V to +20V
◇ VGH to GND	-----	-0.3V to +36V
◇ FB, FBP, FBN, DLY, VDET, $\overline{\text{RST}}$ , COMP, VFLK, REF	-----	-0.3V to (VIN + 0.3V)
◇ OPP, OPN, OPP, DRVP, DRVN to GND	-----	-0.3V to (AVDD + 0.3V)
◇ VGHM, VGH, DRN	-----	-0.3V to +30V
◇ Operating Junction Temperature Range (TJ)	-----	-40°C to +150°C
◇ Operation Ambient Temperature Range	-----	-40°C to +85°C
◇ Storage Temperature Range	-----	-65°C to +150°C
◇ Maximum Soldering Temperature (at leads, 10sec)	-----	+260°C
◇ Maximum Junction Temperature	-----	+150°C

**Note 1.** 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.

## Thermal Information

◇ Thermal Resistance		
QFN-24 4x4, $\theta_{JA}$	-----	78°C/W
QFN-24 4x4, $\theta_{JC}$	-----	25°C/W



## Electrical Characteristics

( $V_{IN}=5V$ ,  $V_{AVDD}=13V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>General</b>						
$V_{IN}$ Input Supply Voltage	$V_{IN}$		2.5		5.5	V
AVDD	AVDD		6		18	V
AVDD Over Voltage Protect	$V_{OVP}$			18	20	V
Boost Switching Frequency	$F_{LX}$		1	1.2	1.4	MHz
Charge Pump Frequency	$F_{CP}$		500	600	700	kHz
$V_{IN}$ Supply Current	$I_Q$	VFB=1.5V, LX no Switching		0.4	0.8	mA
		VFB=1.2V, LX Switching		2.3	5	mA
AVDD Operation Current	$I_{AVDD}$	$V_{OPP}=5V$		1.2	3	mA
Input UVLO Threshold	$V_{UVLO(VTH)}$	$V_{IN}$ Rising	2.15	2.25	2.35	V
UVLO Threshold Hysteresis	$V_{UVLO(HYS)}$	Falling Hysteresis		100		mV
Reference Voltage	$V_{REF}$		1.238	1.25	1.262	V
Thermal Shutdown Threshold	$T_{SD}$			160		$^{\circ}C$
Thermal Shutdown Hysteresis				30		$^{\circ}C$
<b>Boost Regulator</b>						
Maximum Duty-Cycle	$D_{MAX}$		86	90	94	%
Feedback Voltage	$V_{FB}$		1.238	1.25	1.262	V
Transconductance of Error Amplifier	$G_m$	$\Delta I_{COMP}=5\mu A$		85		$\mu A/V$
Voltage Gain	$A_V$			1500		V/V
Switch-ON Resistance	$R_{DS(ON)}$			200		m $\Omega$
Current Limit	$I_{Limit}$		2.5	3		A
LX Leak Current	$I_{Leak}$	LX Off.		0.01	20	$\mu A$
Internal Soft Start Time	$T_{SS}$			10		ms
UVP Fault Protection Voltage	$V_{UVP}$	$V_{FB}$ Falling	0.95	1	1.05	V
UVP Fault Delay	$T_{UVP}$			55		ms
Short Circuit Protection Voltage	$V_{SCP}$			100		mV
<b>Voltage Detector</b>						
Detecting Voltage Adjustment	$V_{DET}$	HYS=50mV		1.25		V
$\overline{RST}$ Pull Low Voltage	$V_{\overline{RST}}$	$I_{RST}=5mA$			0.2	V
$\overline{RST}$ Blanking Time	$T_{\overline{RST}}$		140	160	180	ms



## Electrical Characteristics (Continued)

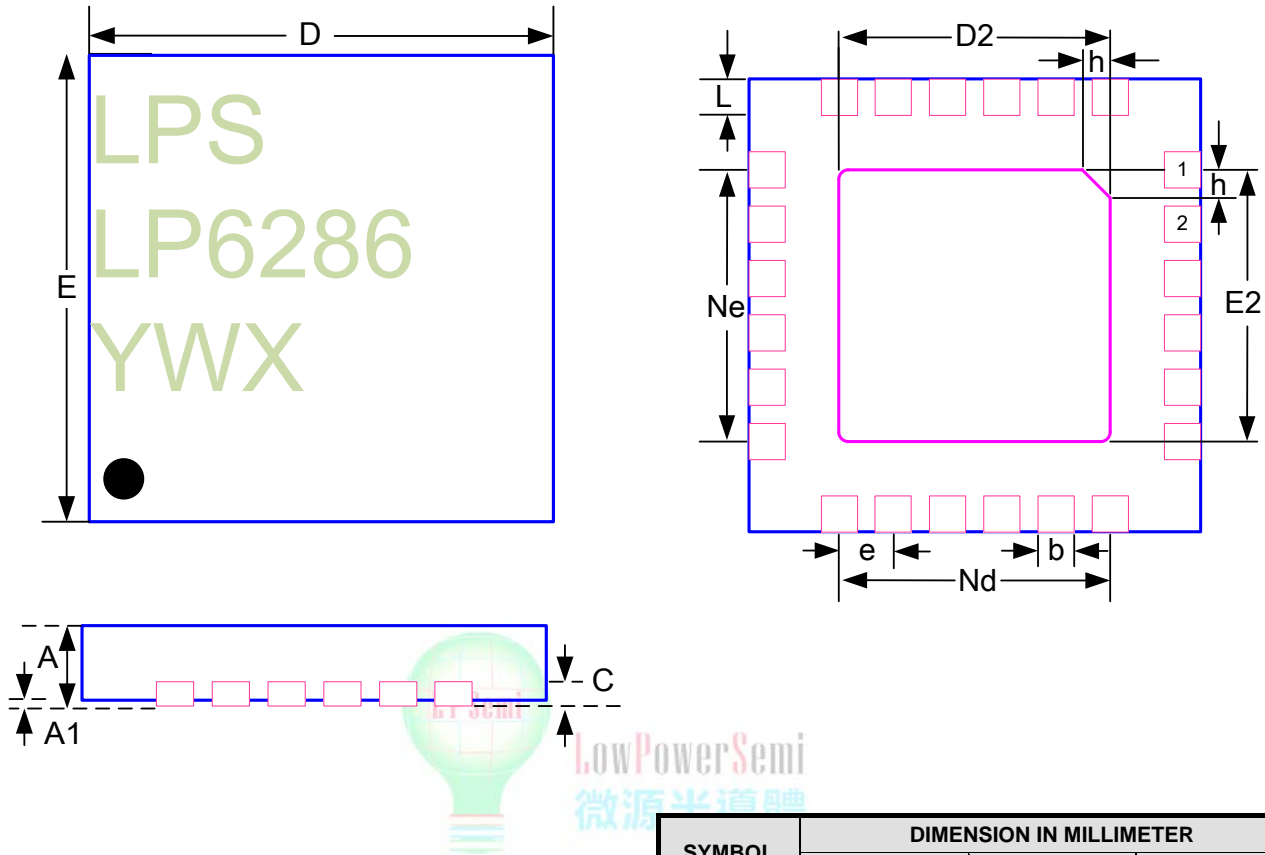
( $V_{IN} = 5V$ ,  $V_{AVDD} = 13V$ ,  $T_A = 25^\circ C$ , unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>Gate Pulse Modulator</b>						
DLY Source Current	$I_{DLY}$		4	5	6	$\mu A$
DLY Threshold Voltage	$V_{DLY}$		1.22	1.25	1.28	V
DLY Discharge Resistor	$R_{DLY}$			10		$\Omega$
VFLK Input High Voltage	$V_{FLK\_H}$		2			V
VFLK Input Low Voltage	$V_{FLK\_L}$				0.5	V
Propagation Delay VFLY to VGHM	$T_{PP}$	$V_{GH} = 30V$		200		ns
VGH Switch ON Resistance	$R_{DS\_GH}$	$V_{DLY} = 1.5V$ , $V_{FLK} = V_{IN}$		15	30	$\Omega$
DRN Switch ON Resistor	$R_{DS\_DRN}$	$V_{DLY} = 1.5V$ , $V_{FLK} = GND$		30	60	$\Omega$
VGHM Discharge Resistor	$R_{DS\_VGHM}$	$V_{DLY} = 1V$	1.5	2.5	3.5	k $\Omega$
<b>Charge Pump</b>						
Charge Pump Soft Start Time	$T_{SS\_CP}$			3.4		ms
Positive Feedback Voltage	$V_{FBP}$		1.23	1.25	1.27	V
DRVP Switch ON Resistance	$R_{DS\_DRVP1}$			3	20	$\Omega$
	$R_{DS\_DRVP2}$			3	20	$\Omega$
Negative Feedback Voltage	$V_{FBN}$		235	250	265	mV
DRVN Switch ON Resistance	$R_{DS\_DRVN1}$			3	20	$\Omega$
	$R_{DS\_DRVN2}$			3	20	$\Omega$
<b>Operation Amplifier</b>						
Input Offset Voltage	$V_{OS}$	$V_{OPO} = V_{AVDD}/2$		2	15	mV
Output Voltage Swing High	$V_{OH}$	$V_{OPP} = V_{AVDD}/2$ , $I_{Load} = -50mA$		5.03	5.06	V
		$V_{OPP} = V_{AVDD}$ , $I_{Load} = 5mA$	9.85	9.92		
Output Voltage Swing Low	$V_{OL}$	$V_{OPP} = V_{AVDD}/2$ , $I_{Load} = 50mA$	4.94	4.97		
		$V_{OPP} = 0V$ , $I_{Load} = -5mA$		0.08	0.15	
Short Circuit Current	$V_{OP\_Short}$	Unity-Gain, $V_{OPO} = V_{AVDD}/2$		$\pm 200$		mA
Slew Rate	SR	$V_{OPP} = 2V$ to $8V$ , $8V$ to $2V$ , 20% to 80%		40		V/ $\mu s$



## Outline Information

QFN-24 Package (4x4) pitch 0.5 (Unit: mm)



SYMBOL	DIMENSION IN MILLIMETER		
	MIN	NOM	MAX
A	0.700	0.750	0.800
A1	---	0.020	0.050
b	0.180	0.250	0.300
C	0.180	0.200	0.250
D	3.900	4.000	4.100
D2	2.400	2.500	2.600
E	3.900	4.000	4.100
E2	2.400	2.500	2.600
e	0.500 BSC		
Nd	2.500 BSC		
Ne	2.500 BSC		
L	0.350	0.400	0.450
h	0.300	0.350	0.400



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