LP5526 Evaluation Kit

National Semiconductor
AN-1502
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General Description

LP5526 is a Lighting Management Unit for portable applications. It can be used to drive display backlight, keypad LEDs, color LEDs and Flash LEDs. The device can drive 2 separately connected strings of LEDs with high voltage boost converter. The RGB driver allows driving either individual color LEDs or RGB LED from separate supply voltage, or it can be used to drive FLASH LEDs.

The MAIN and SUB outputs are high-resolution current mode drivers. RGB outputs can be used in switch mode and current mode. PWM control can be used for any selected outputs.

The device is controlled through 2-wire low voltage I²C compatible interface that reduces the number of required connections.

LP5526 is offered in a tiny microSMD-25 package (2.54 mm x 2.54 mm).

Evaluation Kit Overview

LP5526 Evaluation Kit is based on a modular system, where the actual evaluation board is plugged on top of the PC interface board. The interface operates through the USB port.

The kit supports complete functional evaluation of the circuit. The evaluation kit consists of:

• LP5526 evaluation board
• USB interface board
• USB interface cable
• CD including:
   — Evaluation software for PC
   — LP5526 datasheet
   — LP5526 application note
   — MicroSMD package application note AN1112
   — PCB design application note AN1149
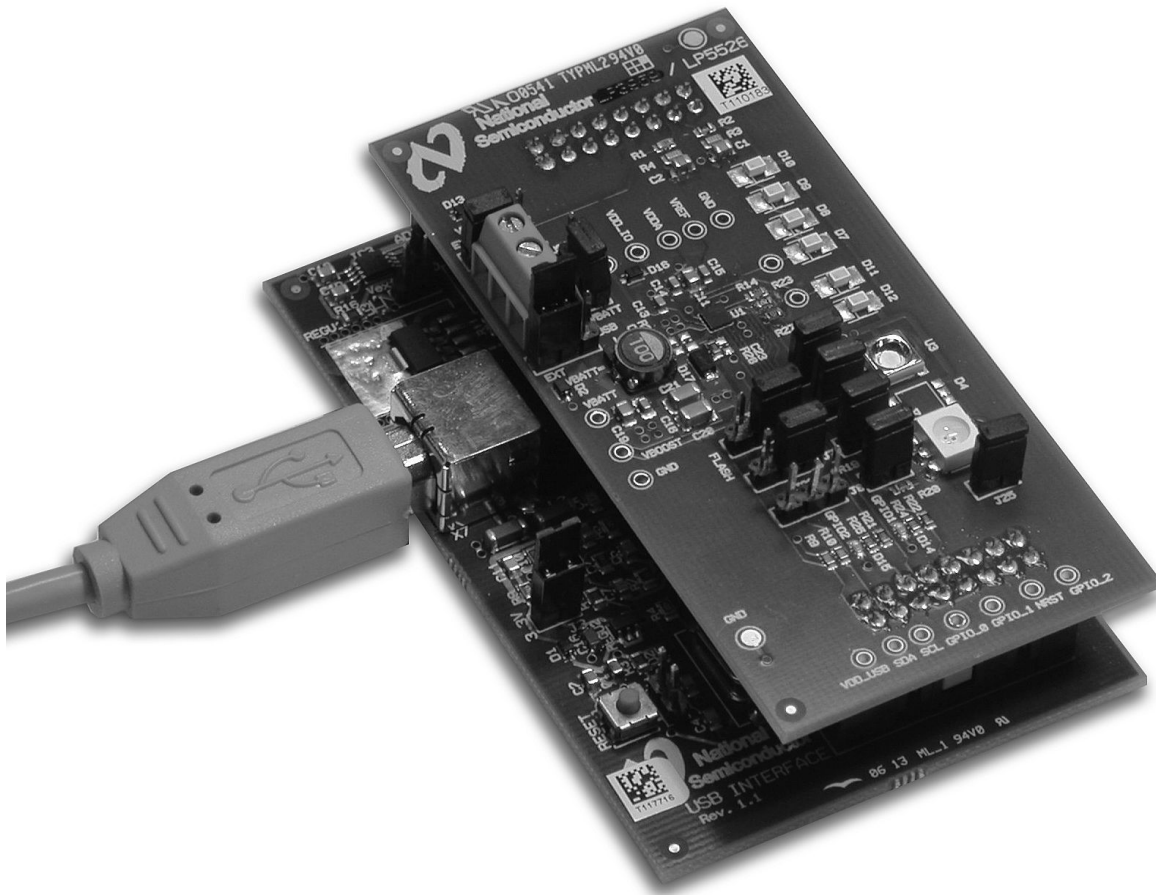   — Evaluation kit document (this doc.)

Figure 1. LP5526 Evaluation board with USB interface board

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Evaluation Software

LP5526 evaluation software and some support files are supplied on the delivery CD together with all available documentation regarding the circuit. You can copy the software and the files to your PC's hard disk. The program and the support files must be in the same folder. The software is started by double-clicking its icon. The software does not require any installation.

The evaluation software is organized in tabs according to the main functions of the chip. On the left side of the tabs is shown the whole register map of LP5526. Below the tabs are shown the registers, which are affected by the selected tab. Both register displays reflect immediately the changes you make by clicking the selection boxes or sliders in the tabs. The contents of the tabs should be mostly self-explanatory. Some example register settings are included in the delivery CD and they can be loaded from the File/Open menu. You can similarly save your own settings.
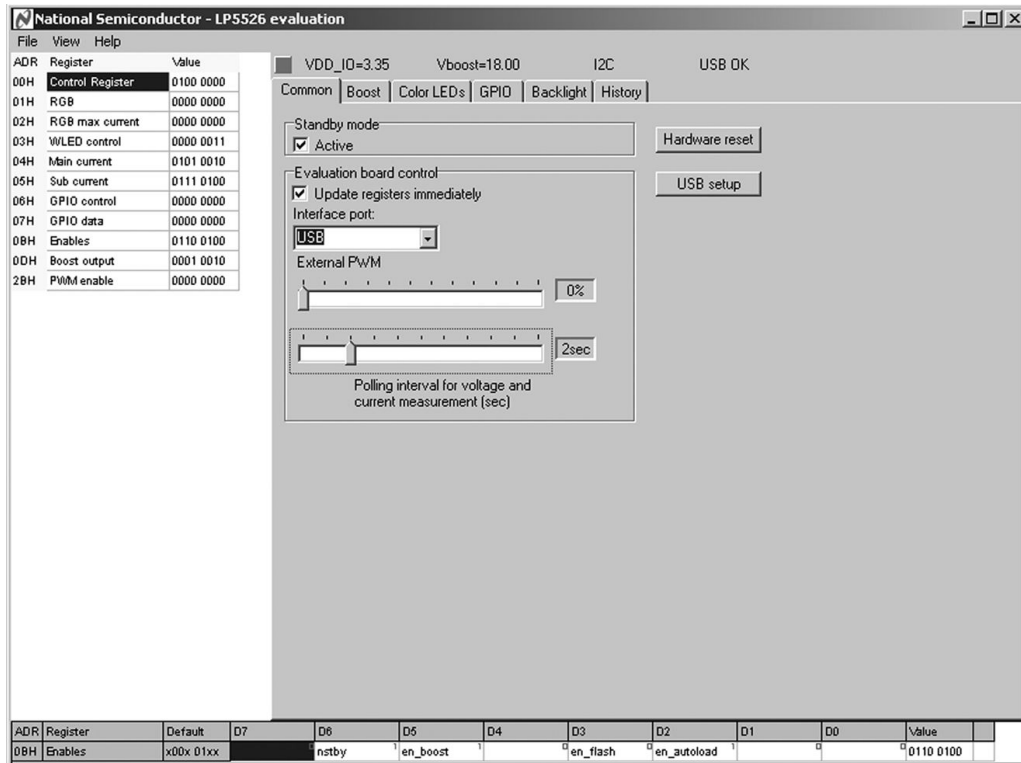

Figure 2. LP5526 Evaluation Software User Interface

COMMON TAB

Only one bit of the Enables register is controlled in the Common Tab. The NSTBY bit controls the chip on/off state.

The Common Tab contains also evaluation board control functions. Automatic writing (Update registers immediately) is enabled by default. It means that a write operation is done after every mouse click. If you want to change several settings in one or more tabs and write the register(s) after making all the changes, you can disable automatic writing. Then after the changes you have to initiate the register write by clicking the right mouse key with the cursor in the Register Map area. From the pop-up menu you can choose to write all registers or just a selected register. The same pop-up lets you write default values to one or all registers and read one or all registers.

After clicking the "Hardware reset" button, all register values will be reset to default value, and a pop-up window appears where user can accept reading all the registers (this is recommended). Another way to reset the chip is to disconnect the USB cable (or external power if it is used) for a few seconds, plug it in again and read all registers to see that they have the default values after the power-on-reset. USB setup button will restore default setting for USB interface board.

USB board can measure voltages from the evaluation board. On the LP5526 board the circuit V_{DDIO} and the converter output voltage V_{BOOST} are measured. Measurements are enabled, when the Polling interval in the Common tab is set. Measurement results are shown on top of the window.

The software can demonstrate external PWM brightness control using the GPIO[0]/PWM input. PWM signal is generated by the software. External PWM can only reduce the brightness set by internal controls. All the LEDs have enable bits (en_ext_X_pwm, en_main_pwm, en_sub_pwm) for allowing external PWM control. These bits are controlled in corresponding LED control Tabs (Color LEDs and Backlight). External PWM control has no effect to the outputs that do not have enable bit set. You must also set 'en_pwm_pin' bit in GPIO tab to set GPIO[0]/PWM pin act as an external PWM input pin.

Note that when Flash button (in Color LEDs Tab) is used and released, it resets the PWM pulse ratio. In the Common Tab the External PWM slider controls the duty cycle of the GPIO [0]/PWM input pin. Measurement polling disturbs the External PWM control and it should be turned off when External PWM is used.

BOOST TAB

Figure 3. Boost Tab

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In this tab LP5526 boost converter can be enabled, and the output voltage can be set from the pull-down menu. The internal active load can be enabled to eliminate pulse skipping of the boost converter. Active load will consume some power when the boost output current is small. It will decrease efficiency at very light load conditions. See datasheet for boost converter typical performance graphs.

COLOR LEDS TAB

Figure 4. Color LEDs Tab

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In this tab are all RGB LED controls. RGB outputs are enabled with 'RGB' selection box, every color output has also individual enable. 'RGB PWM' enables the internal PWM generation and color selection. RGB outputs' mode can be selected either 'Current sink', or 'Switch mode'. Default is 'Switch mode'. In 'Switch mode' the outputs are low ohmic switches. 'Switch mode' should be used only when external ballast resistors are used in series with the LEDs.

With 'RGB color and bright' section it is possible to control the RGB LED color with PWM. In overlapping mode color cannot be selected. In the diagram the LED on/off times are presented.

'RGB maximum' current can be selected for each output from 25% to 100%. Evaluation board resistor R23 and R27 limits the maximum RGB current; default value 2.4 kΩ or 2.4 + 3.3 = 5.7 kΩ when jumper J26 is disconnected. Current limiting function is active only if 'Current Sinks' is selected.

Remember that with Flash LED, only the Current Sink mode should be used, NOT Switch mode since there is no current limiting resistor in series with Flash LEDs. Switch mode should be used only when RGB led is used and current limiting resistors are not bypassed (jumpers J6-J8 off).

External PWM control can be enabled to each output. These must be enabled, when the Flash function is used. Flash button forces GPIO[0]/PWM pin to high. It is active only when it is kept pressed down, and will be low only after release the Flash button. Remember to set USB PortA GPIO[0] as output and set 'en pwm pin' from GPIO tab.

'Check bit' button can be used any time to read back the 'safety_set' bit value. The bit is set when safety function has switched LED's off due to 1s timeout. 'safety_set' bit is read automatically always when user pushes Flash button down and also when it is released.

The 'R_{RGB} calculator' selection can be used to estimate required R_{RGB} resistor value for the specific current. It is for calculation purposes only and does not control the current in any way.
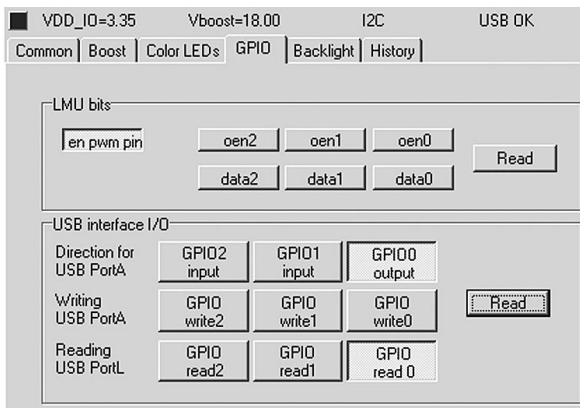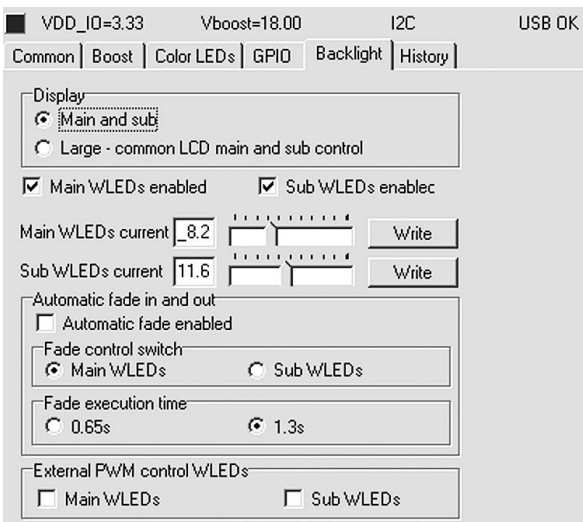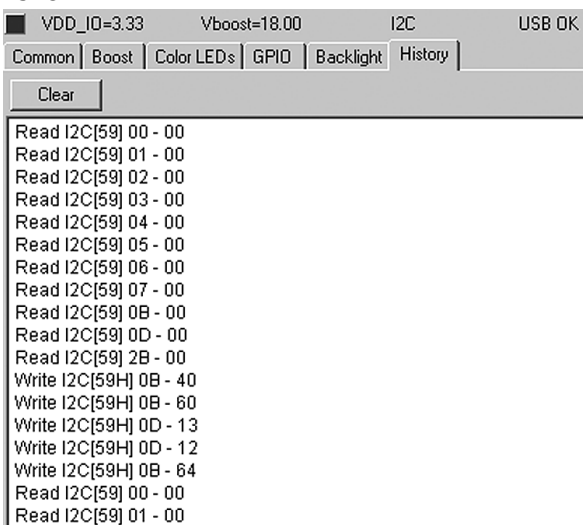
GPIO TAB

Figure 5. GPIO Tab

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In this tab it is possible to control GPIO bits and configure USB board for reading/writing. Port A, B and L refer to USB interface boards ports. Direction of the LP5526 GPIO pins can be set with 'oenx' controls. With the 'datax' controls it is possible to set the state of the GPIO pins, when they are set as output (oenx = 1 / pressed down). When the GPIO pins are set as input, these 'datax' buttons work as an indicator, and you can read the state of the pins with the read-button.

With the USB interface I/O section it is possible to set/read the GPIO pins state.

It is possible to configure port A of USB board as output or input. If you want to use LP5526's GPIO0…2 as output, you have to configure port A as input.

It is important that 'en_pwm_pin' bit is set and GPIO0 (in USB interface I/O) is set as output, if you want to use GPIO0 as PWM input for any purpose (RGB, WLED or FLASH triggering).

BACKLIGHT TAB

Figure 6. Backlight Tab

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In this tab the backlight LEDs can be controlled. Main and Sub outputs can be enabled individually. If you select Large display mode, all LEDs are controlled by the main WLEDs controls (also fading).

Current setting for the outputs are done with the sliders. You can move the slides with arrow keys for more precise control, or write values directly. Pressing 'Write' button writes adjusted values to registers.

You can enable fade function by setting 'Automatic fade enabled'. When new current value is set, the WLED currents will automatically fade smoothly to new value. You can select which LEDs fade effects. When 'Large' display mode is on, set 'Fade control switch' to Main WLEDs to enable fading of all WLEDs.

'Fade execution time' refers to the time to execute full range current change in WLEDs.

External PWM control can be enabled to both Main and Sub individually. External PWM input pin is GPIO[0].

HISTORY TAB

Figure 7. History Tab

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The History Tab records the command sequence of your session. I2C address is on square brackets [], then register address and last is the data in hex format. You can copy-paste this information to another application.

Evaluation Hardware

The evaluation board has the LP5526 circuit with the necessary external components placed around it. Test points for the circuit pins are on the board edges. PCB connectors make the connection to the USB interface board or some other controller if needed.

The supply voltage V_{BATT}, ground GND and I/O-voltage V_{DDIO} can be connected in the green power connector. When the USB interface is used, the V_{BATT} can be either external power or supplied from the USB board, but the V_{DDIO} supply is recommended coming from the USB board (Jumper J21 set to USB). When USB power for V_{BATT} is used, set also the J1 jumper in USB board to 5V to ensure sufficient input power from USB. V_{BATT} jumper J17 sets V_{BATT} between external power or USB power (5V). LP5526's V_{DD} voltage can be set

with J19 jumper to be same as V_{BATT} voltage (external power or 5V from USB) or regulated 3.3V from USB board. Latter is recommended.

The RGB output has current limiting resistors, which can be shorted with jumpers J6 – J8. If you short the resistors, make sure that you use the RGB drivers in the constant current mode. The default after power-on-reset is switch mode. When constant current mode is used, resistors R23 and R27 limits RGB current; when jumper J26 is disconnected Rrgb is set to 2.4k + 3.3k = 5.7 kΩ, and when J26 is set, R27 is bypassed and resistance is 2.4 kΩ. By disconnecting J26 jumper it is possible to use lower RGB currents and therefore USB-power is not overloaded even if Flash is used.
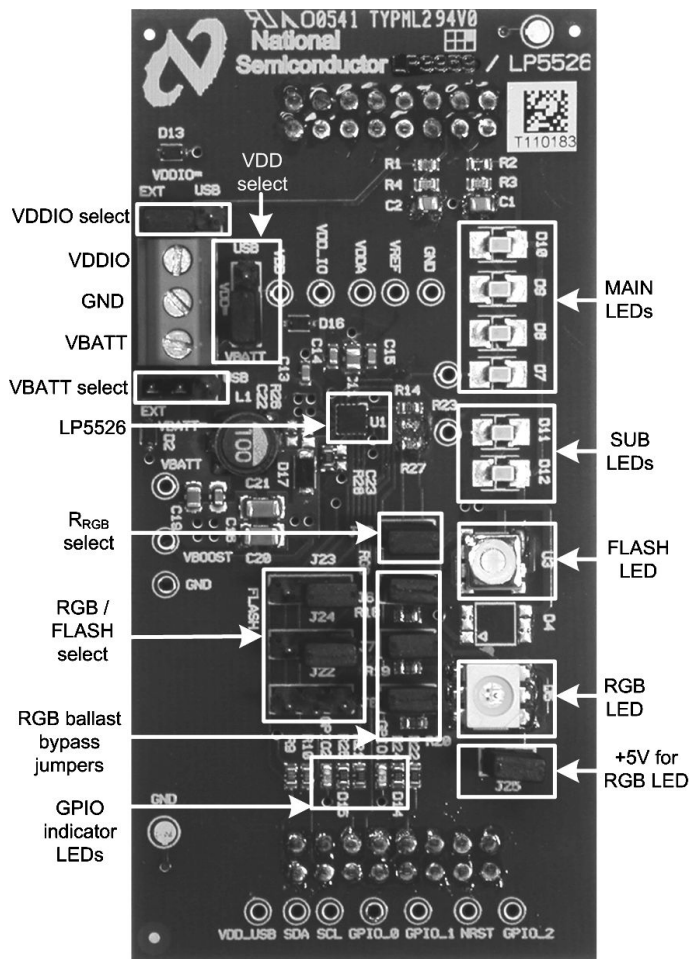

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Figure 8. LP5526 Evaluation Board

Jumpers and Settings

The following tables summarize the jumpers and proper settings.

Jumper	Purpose	Note
J6-J8	Shorting jumpers for current limiting resistors	If jumpers J6-J8 are set, current sink mode for RGB must be set in LP5526.
J17	Choose power supply V_{BATT} = USB or External	USB has very limited current capability. External power connection to X1 connector recommended when high loads are used.
J19	Choose V_{DD} voltage = V_{BATT} or regulated 3.3V from USB	USB recommended.
J21	Choose V_{DDIO} voltage = External voltage or USB interface board	USB unless external IO voltage connected to X1 connector.
J25	Power for RGB LED	RGB led uses voltage (5V) from USB interface board.
J22-J24	Choose FLASH or RGB LED use	
J26	Choose RGB current	If jumper is set, the maximum RGB current is 50 mA/output (Rrgb = 2.4 kΩ). If jumper is off, the maximum RGB current is 21 mA/output (Rrgb = 5.7 kΩ)

Recommended settings for power supply selecting jumpers

Jumper Name	Jumper #	Power Connection
V_{BATT}	J17	EXT position. Use with USB only is not recommended when high loads are used.
V_{DD}	J19	USB position
V_{DDIO}	J21	0 USB position - EXT position only if external I/O power connected

USB Interface

The USB interface forms the connection between the PC and the evaluation system. It converts the commands from PC to I2C or SPI format. It also provides for adjustable supply voltage (for the evaluation board (if jumper J1 is set to ADJ) and makes possible to measure selected voltages and the input current in the evaluation board. When LP5526 is used with USB board and USB power is used, jumper J1 must be set to 5V setting to ensure sufficient power LP5526 boost converter. However maximum boost output current is not achievable when using USB power because of the limited current from USB.

THE USB INTERFACE FIRMWARE

The USB interface checks for the firmware version of the USB board when the evaluation software is started. If the firmware needs updating, the software prompts you to allow automatic update.
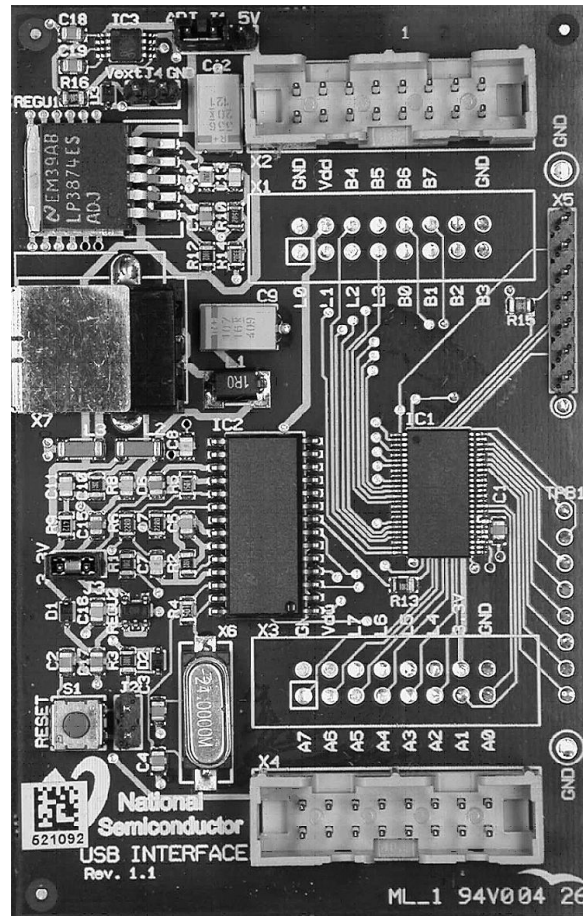

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Figure 9. USB interface board

Getting Started

The following instructions show how to use the LP5526 evaluation kit in default conditions with the USB interface board. Please use the ESD protection (ground cable) to prevent any unwanted damaging ESD events.

1. Check the jumpers and switches on the board according to Figure 8. NOTE especially the power connection jumpers: V_{BATT} is connected to external voltage source; USB power should NOT be used unless you are sure that you are not overloading USB supply. Using FLASH LEDs can overload USB supply. V_{DD} and V_{DDIO} are connected to USB.

2. Plug in the evaluation board to the USB board. Connect the USB cable to the evaluation board and the USB port of your PC. When you plug in the USB board for the first time, your operating system prompts you about "New hardware found" and installs the USB driver automatically. With Win95 and Win98 operating systems you have to accept the installation and click "Next" several times as the installation proceeds.

3. Copy the evaluation software and the support files to your PC's hard disk. Start the software by double-clicking its icon.

4. Press Hardware Reset and USB Setup buttons to reset the chip and the USB interface board.

5. Turn on the chip and the boost converter by clicking stand-by and boost enable.

6. The Evaluation Kit is now ready to use and the chip can be controlled through the PC-software.

If you start the software first and then connect the USB cable, the software may assume, that LPT interface is used. In that case you can select the USB interface manually or close and restart the software.

You should disconnect the USB cable from the computer always, when plugging in or removing the evaluation board from the interface board and also when changing the supply jumper settings. Otherwise the USB board may stop responding.

If the USB board is not responding or the software hangs up, press the reset button on the USB board, or disconnect the USB cable for 5 seconds.

If the evaluation software notices that the firmware on the USB board needs to be updated, the software can propose automatic firmware updating. The new firmware will be included in the evaluation kit software.

EASY START WITH BACKLIGHT DRIVING

1. Attach the USB cable.

2. Attach external voltage source for V_{BATT} (3.60V, 1.5A max current).

3. Launch the SW (LP5526eval.exe). You should get a control window up.

4. Press USB Setup.

5. Go to the File open menu and select the "LP5526wled_on.nsc" file and open it; this will light up the sub and main backlight LED's.

6. Go to the 'Backlight' tab.

7. Try to adjust brightness of main and sub backlight LEDs, together and separately.

EASY START WITH FLASH DRIVING

1. Attach USB cable.

2. Attach external voltage source for VBATT (3.60V, 1.5A max current).

3. Ensure all jumpers are in right position for Flash LED driving.

4. Launch the SW (LP5526eval.exe).

5. Press USB Setup.

6. Go to File open menu and select the 'LP5526flash_enabled.nsc' file and open it; this will light up the Flash LED in Pre-Flash/Torch mode.

7. Go to 'Color LEDs' tab.

8. Press Flash button to trigger flash.

9. To initiate new flash:
    — Disable 'Flash enable' bit, and all safety bits.
    — Enable first 'Flash enable' bit and then all safety bits.
    — Flash LED should be now on Pre-Flash/Torch mode with safety function on, and ready for Flash triggering by pressing the 'Flash' button.
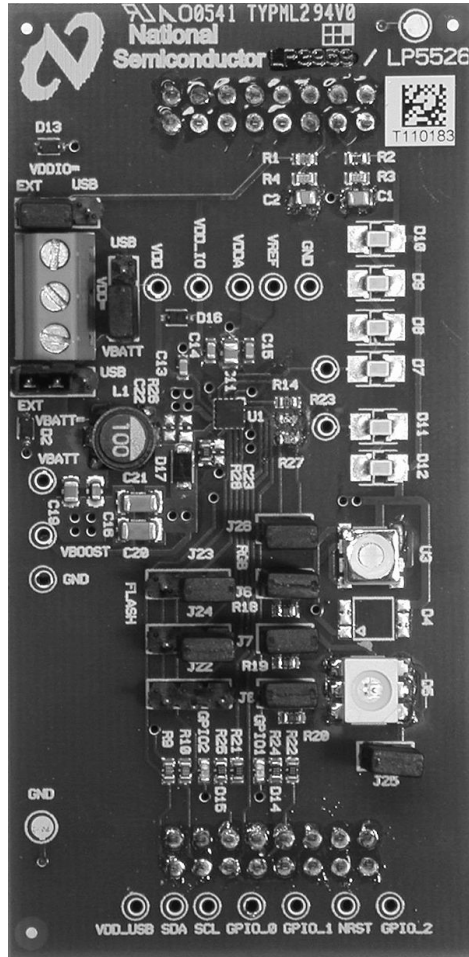
SPECIAL NOTES

IRGB resistor has set to 2,4 kΩ by default (when J26 is set), which limits the Flash current to 150 mA max. Typically boost can provide 150 mA (V_{BATT} = 3.6V, V_{BOOST} = 20V).

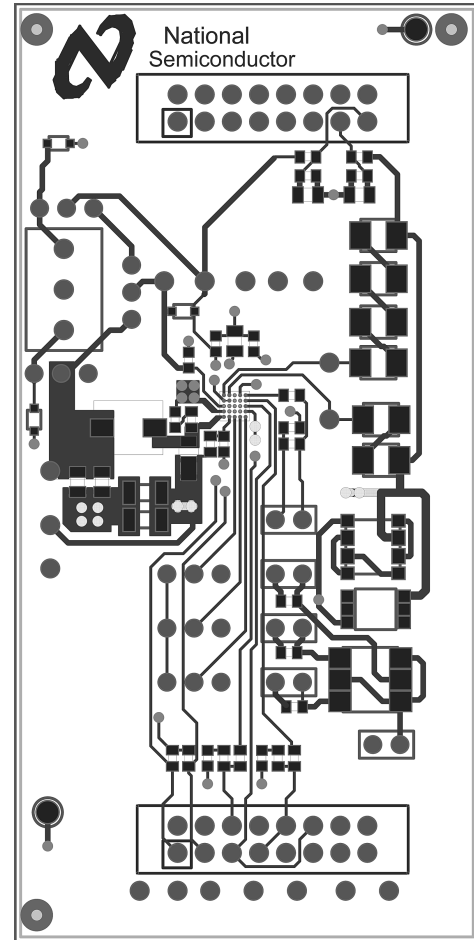**Figure 10. Lp5526 Evaluation Board Schematic**

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Board Layout
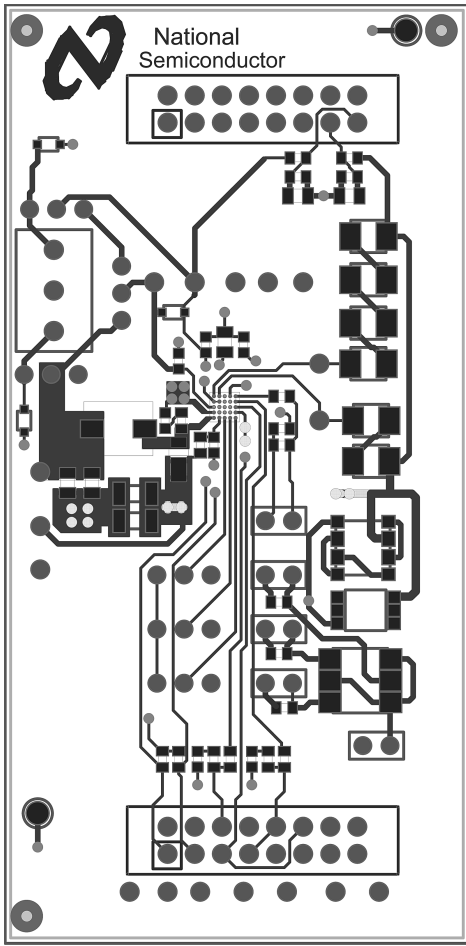

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Figure 11. LP5526 Evaluation board and layout picture

The evaluation board layers are:

1. Top, component side
2. Signal layer
3. GND plane
4. Bottom, solder side, V_{DD_USB}

For the good performance of the circuit, it is essential to place the input, output capacitors, the inductor and the schottky diode very close to the circuit and use wide routing for those components. Sensitive components should be placed far from those components with fast changing current. Decoupling capacitors should be close to circuit's V_{DD} pins.

Good design practices for switching mode power supplies should be used. See Application Note AN 1149, Layout Guidelines for Switching Mode Power Supplies.
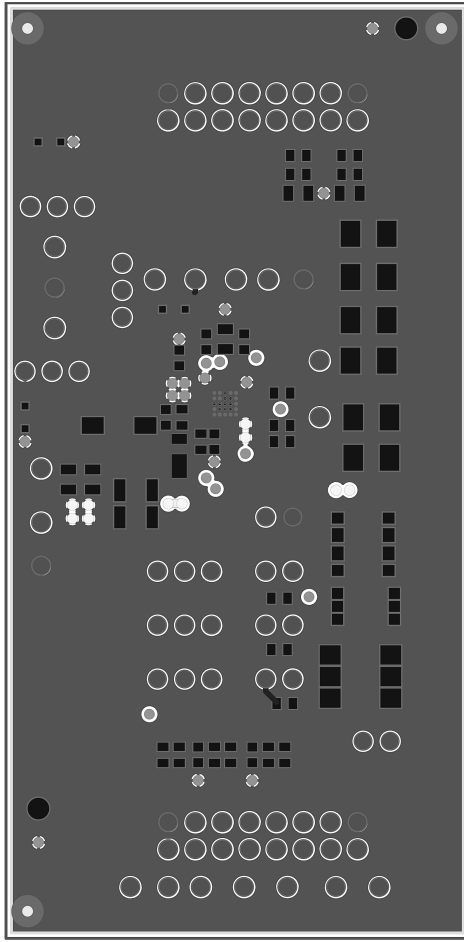
Fig. 12 Lp5526 Evaluation Board Layer 1 (Top, Signal).
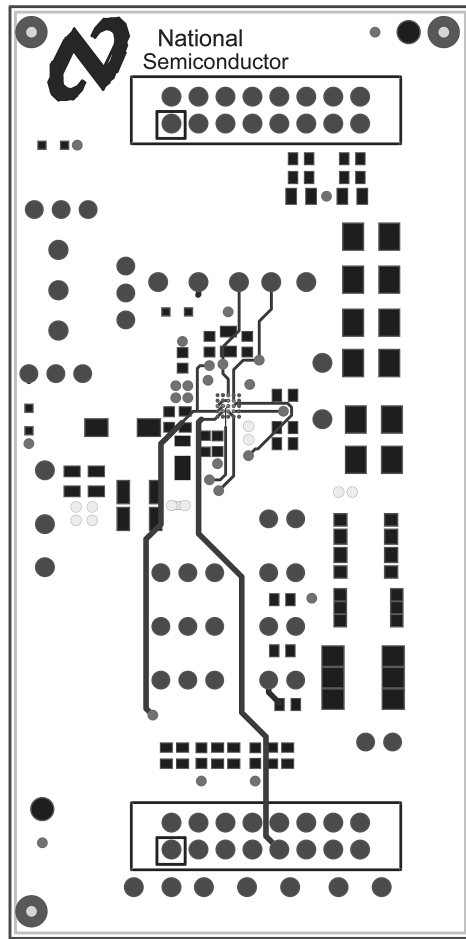
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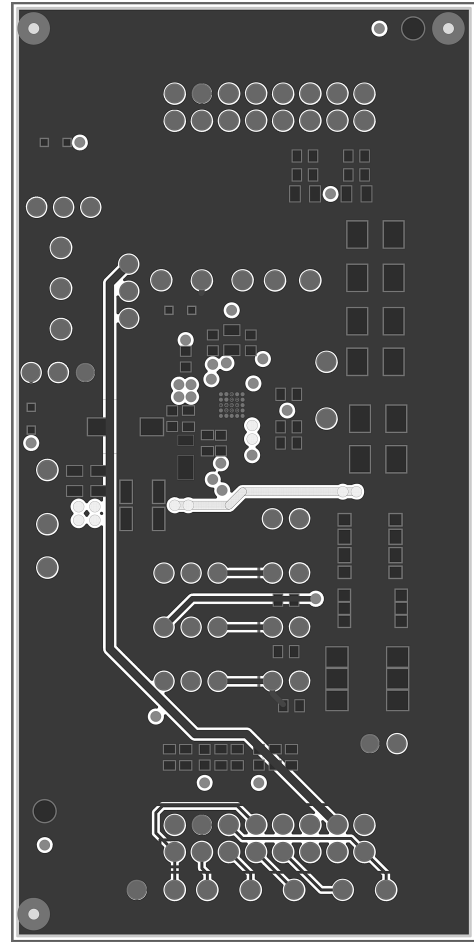
Fig. 13 LP5526 evaluation board layer 2 (signal).

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Fig. 14 Lp5526 Evaluation Board Layer 3 (GND).

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Fig. 15 LP5526 evaluation board layer 4 (bottom, V_{DD_USB}).

List of Main Components

Part number	QTY	Value, Size, Tolerance	Description	Vendor / Type
R1	1	100k 1% 0603		
R2	1	150k 1% 0603		
R3, R4	2	27k 1% 0603		
R9, R10	2	1k5 1% 0603		
R14	1	82k 1% 0603		
R18	1	100R 1% 0603		
R19	1	47R 1% 0603		
R20	1	2R2 1% 0603		
R21, R22	2	0R 1% 0603		
R23	1	2k4 1% 0603	RGB current limitation resistor	
R24,R25	2	330R 1% 0603		
R26	1	390R 1% 0603	**Optional resistor for SW pin EMI filter.**	
R27	1	3k3 1% 0603	RGB current limitation resistor (bypassed with jumper)	
R28	1	0R 1% 0603		
C1,C2, C11	3	1μ −20%+80% 16V 0805	X7R, X5R, multilayer ceramic	
C13, C14, C15, C16	4	100n 10% 16V 0603	X7R, multilayer ceramic	
C19	1	10u 10% 10V 0805		
C20,C21	2	4μ7 10% 25V 1206	X5R, multilayer ceramic, boost output capacitors	TDK C3216X5R1E475K, Panasonic ECJ3YB1E475K, ECJ4YB1E475K
C22	1	330p 10% 50V 0603	**Optional capacitor for FB pin.**	
C23	1	100p 10% 50V 0603	**Optional capacitor for SW pin EMI filter.**	
D2, D13, D16	4	BAT760-SOD323	Schottky Barrier Diode,	Philips
D4	1	LNJOF3C5FRA1-SMD	Flash LED, Panasonic	Panasonic
D5	1	GM5WA06270A-SMD	RGB 3-Color	SHARP
D7…D12	6	LW M67C white	LED LW M67C white	Osram
D14, D15	2	LED LS L296-N1Q2-1-Red-SMD	LED LS L296-N1Q2-1, 0603, Red	Osram
D17	1	CMMSH1-40	Schottky Barrier Diode for boost	Central Semiconductor
J…	4	PINHEADER2	Pin Header 1 x 2 pins, pitch 0.1"	
J...	6	JUMP3	3-pin jumper	
	10	Jumper block		
X1	1	TERMINAL BLOCK FOR PCB3	Terminal Block for PCB, Miniature	
X2,X3	2	EURO16-UPPER	PCB Mounting Header (Upper Board)	
U1	1	LP5526TL	LMU	NSC
U3	1	GM5BW05340AC	Flash LED	SHARP
L1	1	Power Inductor 10 μH	Shielded, > 1.5A sat. current	TDK SLF6028T-100M1R3, Coilcraft MSS6122-103MLB

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Notes

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