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SANYO Semiconductors

DATA SHEET

LV8280T — Bi-CMOS LSI DVD-ROM Spindle Motor Driver IC

Overview

LV8280T is s sensorless motor driver that provides a reverse torque braking function and is appropriate for spindle motor drive in CD-ROM, DVD and similar drives. This IC adopts a direct PWM drive technique and uses MOSFETs as its output transistors for highly efficient motor drive.

Since the LV8280T can implement a motor drive system without the use of Hall-effect devices, it can contribute to motor system miniaturization, thinner form factors, and lower power consumption.

Features

- Three-phase full-wave, sensorles drive method and Direct PWM drive

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage	V_{CC} max		6.0	V
Motor power supply voltage	VS max		6.0	V
Pre-drive voltage (gate voltage)	VG max		10	V
Maximum output current	I_O max		1.0	A
Allowable power dissipation 1	Pd max1	Independent IC	0.5	W
Allowable power dissipation 2	Pd max2	* Mounted on a board.	1.2	W
Operating temperature	Topr		-10 to +75	°C
Storage temperature	Tstg		-40 to +150	°C

* : Mounted on a board : 76.1×114.3×1.6mm^3, glass epoxy board

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Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage	V_{CC}		4.5 to 5.5	V
Motor power supply voltage	VS		0 to V_{CC}	V
Predriver voltage (gate voltage)	VG		VS+3.5 to 9.5	V

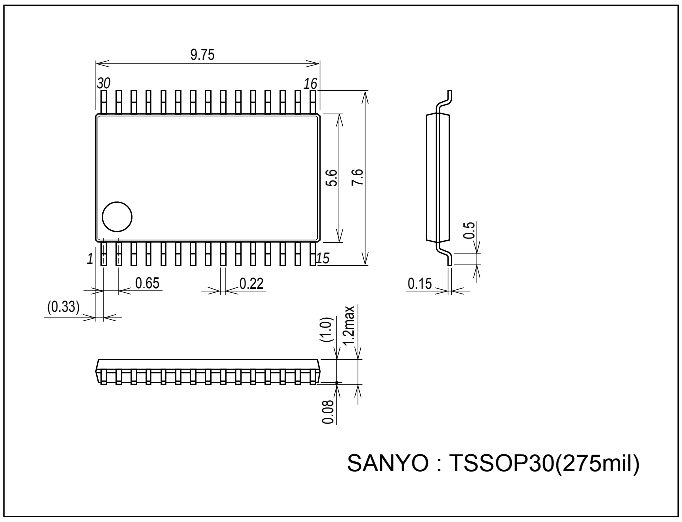
Electrical Characteristics at Ta = 25°C, V_{CC} = 5V

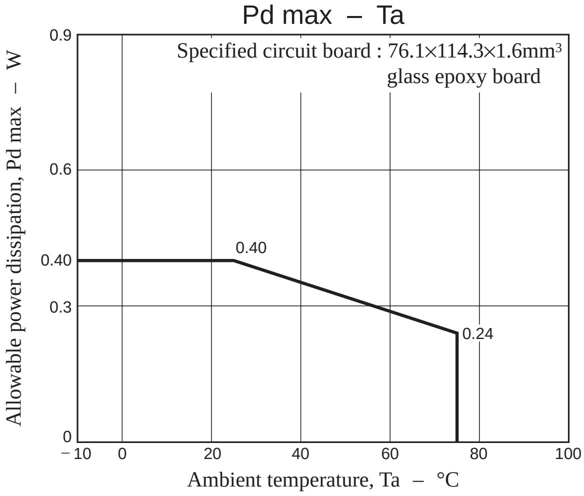
Parameter	Symbol	Conditions	min	typ	max	Unit
Current drain 1	$I_{CC}1$	S/S pin : high level	3.0	4.1	6.0	mA
Current drain 2	$I_{CC}2$	S/S pin : low level(standby mode)			20	μA
Charge Pump Output						
Output voltage	VCP		9.1	9.5	9.9	V
Internal Oscillation Circuit						
Internal oscillation frequency	f clk		3.0	3.2	3.4	MHz
Output block						
SOURCE 1	Ron (H1)	I_O = 0.5A, VS = 5V, VG = 9.5V, Forward transistor		0.25	0.5	Ω
SINK	Ron (L)	I_O = 0.5A, VS = 5V, VG = 9.5V		0.25	0.5	Ω
SOURCE+SINK	Ron (H+L)	I_O = 0.5A, VS = 5V, VG = 9.5V		0.5	1.0	Ω
Position Detector Comparator						
Input offset voltage	VOFS	*Design target value	-10		10	mV
Control						
VCREF input voltage range	VCREF			1.65		V
VCTL input voltage range	VCTL	VCREF = 1.65V	0		V_{CC}	V
Current Control Circuit						
Forward drive gain	GDF^+		0.20	0.25	0.30	fold
Reverse drive gain	GDF^-		-0.30	-0.25	-0.20	fold
Dead zone width	VDZ	VCREF = 1.65V	100	150	200	mV
Limiter voltage	VRf		0.18	0.20	0.22	V
VCO Pin						
VCO high-level voltage	VCOH		0.8	1.0	1.2	V
VCO low-level voltage	VCOL		0.3	0.5	0.7	V
S/S Pin						
High-level input voltage range	SSH	Start	2.7		V_{CC}	V
Low-level input voltage range	SSL	Stop	0		0.6	V
Break SEL Pin						
High-level input voltage range	BRH	Short-circuit braking	2.7		V_{CC}	V
Low-level input voltage range	BRL	Reverse torque braking	0		0.6	V
FG Output Pin						
Output saturation voltage	FGsat	I_O = 0.5mA			0.5	V
Thermal Protection Circuit						
Thermal shutdown operating temperature	TTSD	*Design target value	150	180		°C
Thermal shutdown temperature hysteresis	ΔTTSD	*Design target value		40		°C

*Design target value and no measurement is performed.

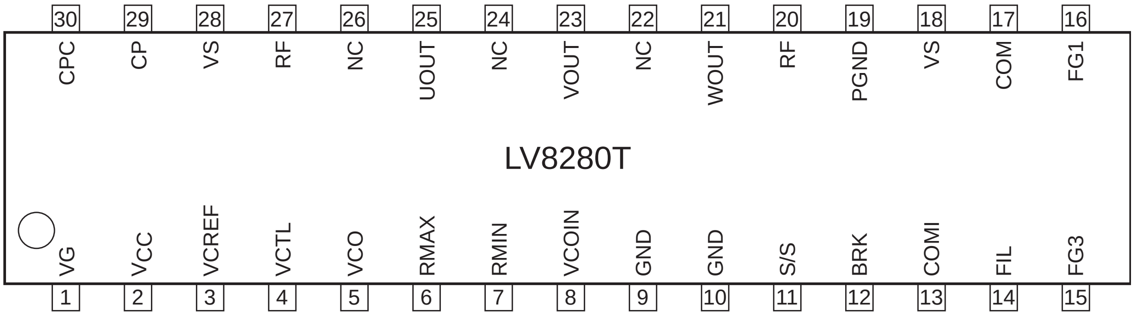
Package Dimensions

unit : mm (typ)
3259

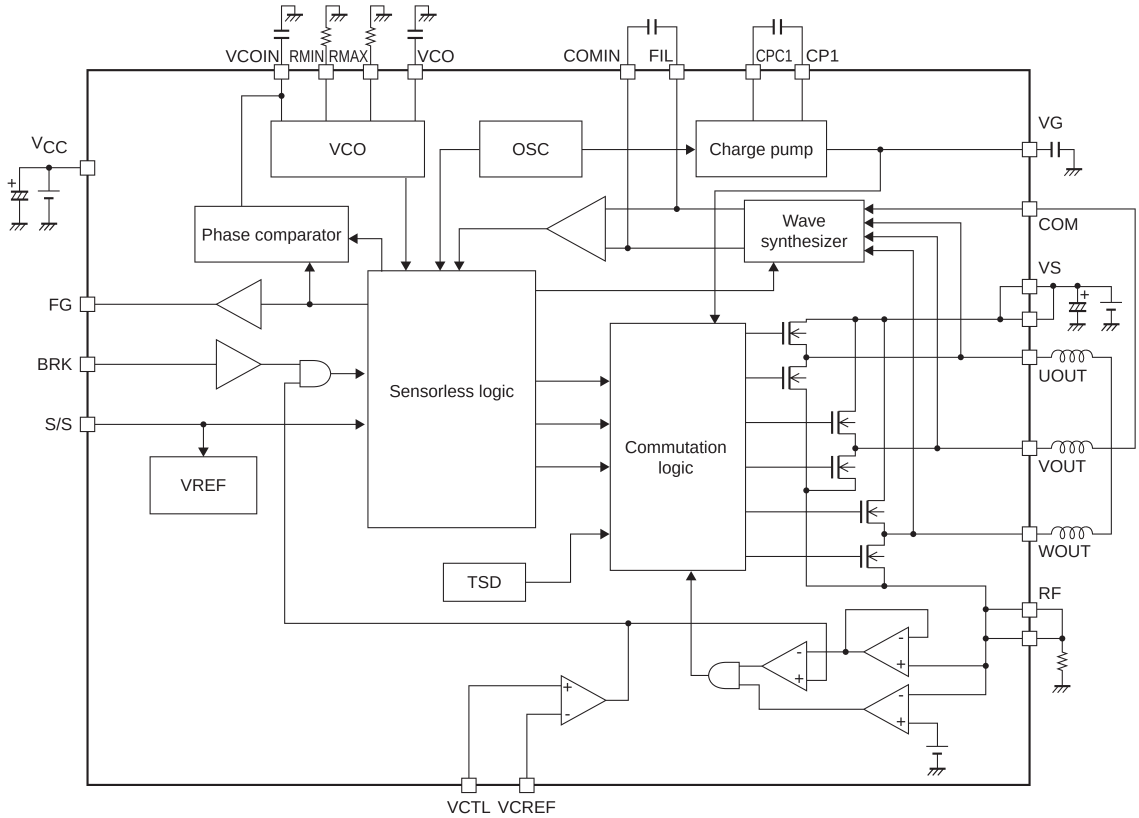




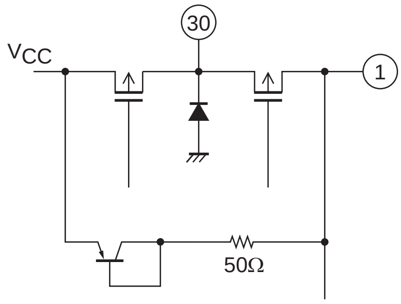
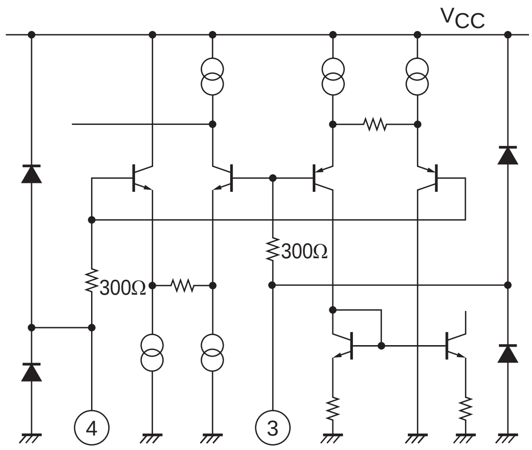
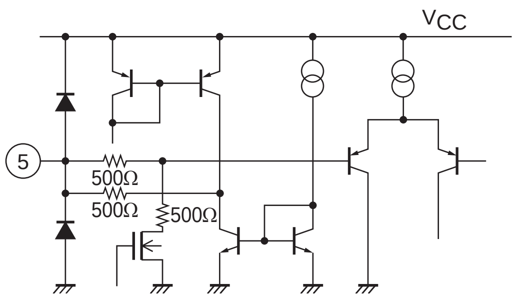
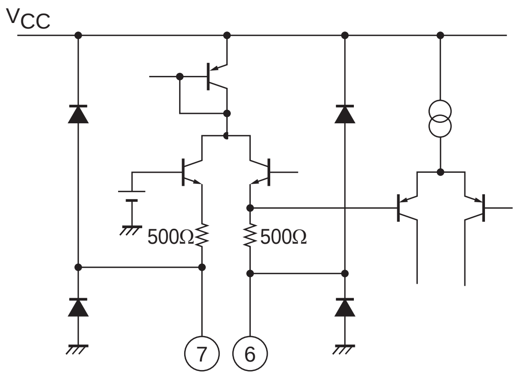
Pin Assignment



Block Diagram



Pin Functions

Pin No.	Pin name	Pin description	Equivalent Circuit
1	VG	Charge pump step-up voltage output. Insert a capacitor between this pin and ground.	
30	CPC	Charge pump step-up pin. Insert a capacitor between this pin and CP (pin 29).	
2	V_{CC}	Small-signal system power supply. Insert a capacitor between this pin and ground	
3	VCREF	Speed control reference voltage input	
4	VCTL	Spindle speed control	
5	VCO	VCO oscillator. Insert a capacitor between this pin and ground. VCO oscillation frequency changes with the spindle motor rotational speed.	
6	RMAX	VCO highest frequency setting. Insert a resistor between this pin and ground. Making the value of the resistor smaller increases the frequency. Set the frequency so that the VCO oscillator frequency when the VCOIN pin voltage is V_{CC} - 1 V is over 96 times the switching frequency at the maximum motor speed.	
7	RMIN	VCO lowest frequency setting. Reducing the value of the connected resistor increases the frequency.	

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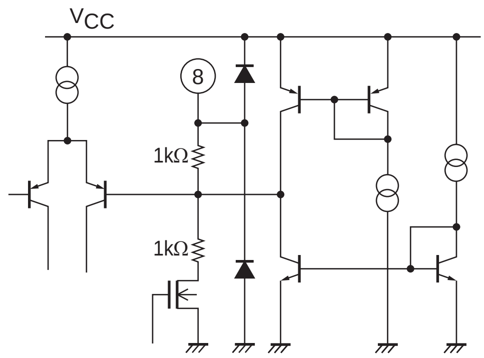
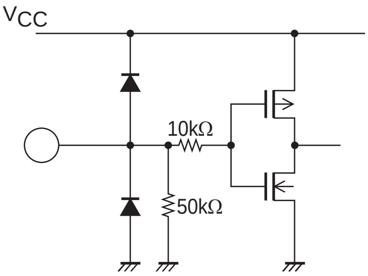
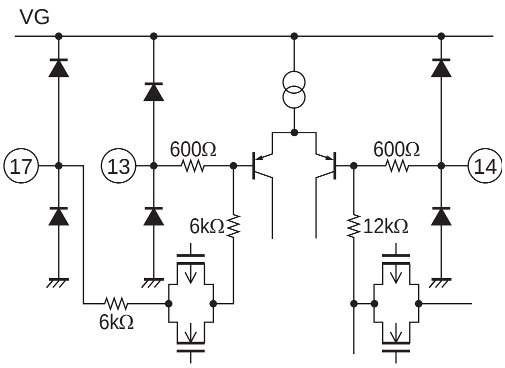
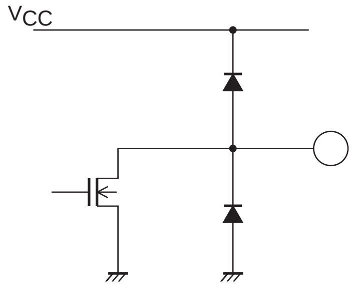
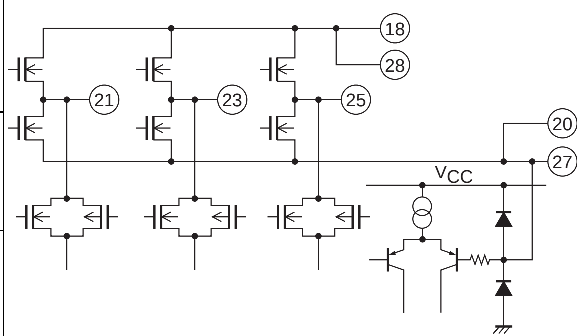
Pin No.	Pin name	Pin description	Equivalent Circuit
8	VCOIN	VCO control voltage input. Insert a capacitor between this pin and ground.	
9 10	GND	Small-signal system ground.	
11	S/S	Spindle motor start/stop control. Apply a high level for the start state.	
12	BRK	Spindle motor braking type switching control Low level: reverse torque braking. High level: short-circuit braking.	
13	COMIN	Motor position detection comparator input. Insert a capacitor between this pin and FIL (pin 14).	
14	FIL	Motor position detection comparator input. Insert a capacitor between this pin and COMIN (pin 13).	
17	COM	Spindle motor COM point connection.	
15	FG3	FG3 pulse output. Outputs a pulse signal equivalent to a three Hall sensor system pulse output. Open-drain output.	
16	FG1	FG1 pulse output. Outputs a pulse signal equivalent to a one Hall sensor system pulse output. Open-drain output.	
18 28	VS	Spindle motor drive power supply. Insert a capacitor between this pin and ground.	
21 23 25	WOUT VOUT UOUT	Outputs. Connect these pins to the motor coils.	
20 27	RF	Output current detection. The drive current is detected using a small resistor inserted between this pin and ground.	
19	PGND	Large signal system ground.	
22 24, 26	NC	Not connected	

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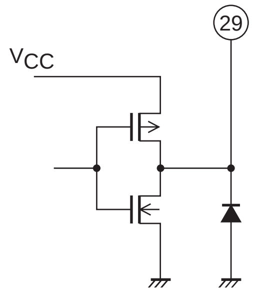
Pin No.	Pin name	Pin description	Equivalent Circuit
29	CP	Charge pump step-up pulse output. Insert a capacitor between this pin and CPC pin (pin 30).	

LV8280T Functional Description and Notes on External Components

This document presents information necessary to design systems with the best possible characteristics and should be read before designing driver circuits using the LV8280T.

1. Output Drive Circuits and Speed Control Methods
   The LV8280T adopts a synchronous commutation direct PWM drive method to minimize power loss in the output. Low on-resistance DMOS devices are used as the output transistors. (The upper and lower side output block device on-resistance is 0.5Ω (typical).)
   The LV8280T spindle drivers control system takes an analog input and uses a V-type control amplifier. The V-type control amplifier based speed control system (gain : 0.25typical) controls the speed by controlling the voltage of the VCTL pin (pin 4) and the VCREF pin (pin 3). The circuit provides positive torque when VCTL is greater than VCREF, and allows the application to select either reverse torque braking (when the BRK pin is low) or shortcircuit braking (when the BRK pin is high) when VCTL is less than VCREF. The PWM frequency is twice the frequency of the charge pump pulse rate (pin 29).

2. Soft Switching Circuit
   This IC performs “soft switching”, which is a technique that varies the duty and achieves quieter motor operation by reducing the level of motor drive noise. This IC provides a “current application on/off dual sided soft switching” type soft switching function.

3. Current Limiter Circuit
   The current limiter circuit current limit value is determined by Rf in the equation I = VRF/Rf (here, VRF = 0.20V, typical). The current limiter circuit detects the RF pin (pins 20 and 27) peak current and turns the sink side transistor off.
   This IC provides two RF pins, which are connected to the same circuit components internally. However, we recommend that these pins be shorted externally to provide the highest drive efficiency. (The VS pins should be handled in the same manner.)

4. Notes on VCO Circuit Constant Determination
   The LV8280T spindle block adopts a sensorless drive method. In sensorless drive, the IC uses the VCO signal to control the timing and other aspects so that it can determine the timing with which it applies power to the motor by detecting the back EMF signal generated by the motor. We recommend the following procedure to determine the VCO circuit external component values.
   1) Connect external components with recommended and provisional values.
      Connect a capacitor with the recommended value (3300pF) between the VCO pin (pin 5) and ground, connect a capacitor with the provisional value (1μF) between the VCOIN pin (pin 8) and ground, connect a 220kΩ resistor between the RMIN pin (pin 7) and ground, and connect a 68kΩ resistor between the RMAX pin (pin 6) and ground.
   2) Determine the optimal value of the resistor connected to the RMIN pin (pin 7).
      The RMIN pin resistor determines the startup frequency (the VCO oscillator frequency when the VCOIN voltage is 0V). Select a value for this resistor that achieves the shortest possible startup time (the time until the target speed is reached) and that also minimizes the variations in the startup time. If the resistor value is increased, the startup frequency will be reduced, and if the resistor value reduced, the startup frequency will be increased. If the startup frequency is too low, the variations in the startup time will be increased, and if the value is too large, the motor may idle without engaging.
      Since the optimal value of the RMIN pin resistor depends on the characteristics of the motor and the startup current, this value must be checked if a different motor is used or if the circuit specifications are changed.

3) Determine the optimal resistance of the RMAX pin (pin 6) resistor.
The dynamic range of the VCOIN pin voltage is set by the value of the resistor connected to the RMAX pin. With the motor running at the maximum operating speed, select a resistance that brings the VCOIN pin voltage to about V_{CC} – 1.1 (V) (or lower). If the resistance is too large, the VCOIN pin voltage may rise.

4) Determine the optimal capacitance of the VCOIN pin (pin 8) capacitor.
With the motor running at the minimum operating speed, increase the value of the VCOIN capacitor if the FG output (pins 15 and 16) pulse signal is unstable.

5. S/S Circuits
The S/S pin (pin 11) is the start/stop pin; a high level selects the start (operate) state. Set the S/S pin to the low level to put the IC in full standby state (power saving mode).

6. BRK Circuit
The BRK pin (pin 12) switches between reverse torque and short-circuit braking; a high level selects short-circuit braking and a low level selects reverse torque breaking. When the motor speed becomes adequately slow in the reverse torque braking state, the application must switch to the short-circuit braking state to stop the motor. (Note: The IC must not be in the power saving state at this point.)
When stopping the motor in the state where the control voltage, VCTL, is less than VCREF (when a low level is input to the BRK pin), if the timing of the switch to short-circuit braking is too early, and remaining motor rotation is a problem, reduce the value of the RMAX pin (pin 14) resistor. Also, if motor oscillation continues when the motor is nearly stopped, and a switch to short braking mode does not occur, insert a resistor with a value of a few kΩ at the COM pin. (Note: Verify that inserting this resistor does not adversely affect the startup characteristics.)

7. FG Output Circuit
The FG3 pin (pin 15) is the spindle block FG output pin. It provides a pulse signal equivalent to that provided by systems that use three Hall-effect sensors.
The FG1 pin (pin 16) outputs a signal that follows the spindle output U phase back EMF voltage. The FG1 and FG3 pins both have a MOS open-drain output circuit structure.

8. Spindle Block Position Sensor Comparator Circuit
The spindle block position sensor comparator circuit uses the back EMF signal generated by motor rotation to detect the rotor position. The output block power application timing is determined based on the position information acquired by this circuit. Startup problems due to noise on the comparator inputs can be ameliorated by inserting a capacitor (1000 to 4700pF) between the COMIN pin (pin 13) and the FIL pin (pin 14).

9. Charge Pump Circuit
Since the LV8280T has a DMOS (n-channel) output structure, it includes a charge pump based voltage step up circuit. When capacitors (recommended value : 0.22µF or higher) are connected between the CP and CPC pins, the IC generates a level that is twice the V_{CC} voltage (or 9.5V). It is desirable that this IC be used with the voltage relationship between the stepped-up voltage (VG) and the motor supply voltage (VS) meeting the condition VG – VS ≥ 3.5V. Note that the stepped-up voltage (VG) is, by design, clamped at about 9.5V DC. If the stepped-up voltage (VG) exceeds 10V (VG max) due to ripple, the value of the VG pin capacitor must be increased.
Observe the following points if the VG voltage is supplied externally.

1) The externally applied VG voltage must not exceed VGmax in the Absolute Maximum Ratings.
2) The capacitor between the CP and CPC pins (pins 5 and 6) is not required.
3) The sequence in which the VG voltage is applied requires care. The VG voltage must be applied after V_{CC}, and must be removed before V_{CC} is cut.
4) Since there is an internal diode between the V_{CC} and VG pins in the IC, a voltage such that V_{CC} > VG must never be applied to the VG pin.

10. Notes on PCB Pattern Design
The LV8280T is a system driver IC fabricated in a BI-DCMOS process, and includes bipolar circuits, MOS logic circuits, and MOS driver circuits on the same chip. This means that pattern routing and sneak currents must be considered during application circuit design.

1) Ground and V_{CC}/VS lines
The LV8280T ground and power supply pins are classified as follows.
Small-signal system ground pins → GND (pins 9 and 10)
Large-signal system ground pins → PGND (pin 19)

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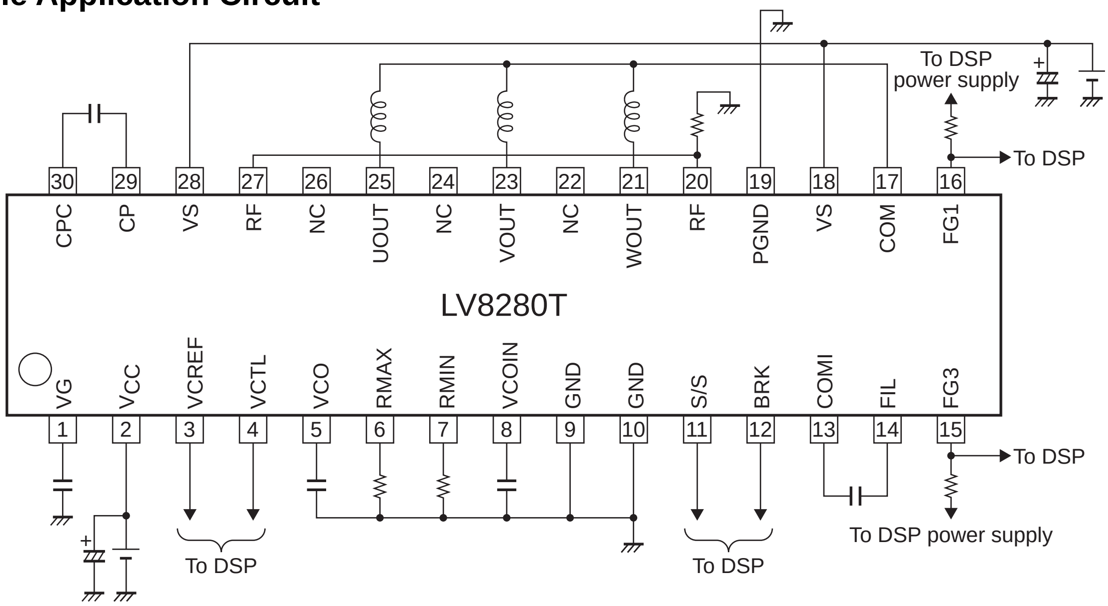
Small-signal system power supply pins → V_{CC} (pin 2)
Large-signal system power supply pins → VS (pins 18 and 28)
Capacitors must be inserted between the small-signal system power supply pin (pin 2) and ground pins (pins 9 and 10). Locate these capacitors as close to the IC as possible.
The large-signal system ground (PGND) pins must not have any shared impedances with the small-signal system ground lines. The large-signal system power supply (VS) pins must also be connected with the shortest distances possible, and capacitors must be inserted between these pins and the corresponding large-signal system ground pin.
Locate these capacitors as close to the IC as possible.

2) Location of small-signal system external components
Of the small-signal system external components, those that are connected to ground must be connected to the small-signal system ground with the shortest possible lines.

Sample Application Circuit



This catalog provides information as of May, 2007. Specifications and information herein are subject to change without notice.