High Energy Ignition Circuit IC

Description

LD3334 (analog MC3334) is designed to use the signal from a reluctor type ignition pickup to produce a well controlled output from a power Darlington output transistor.

Features

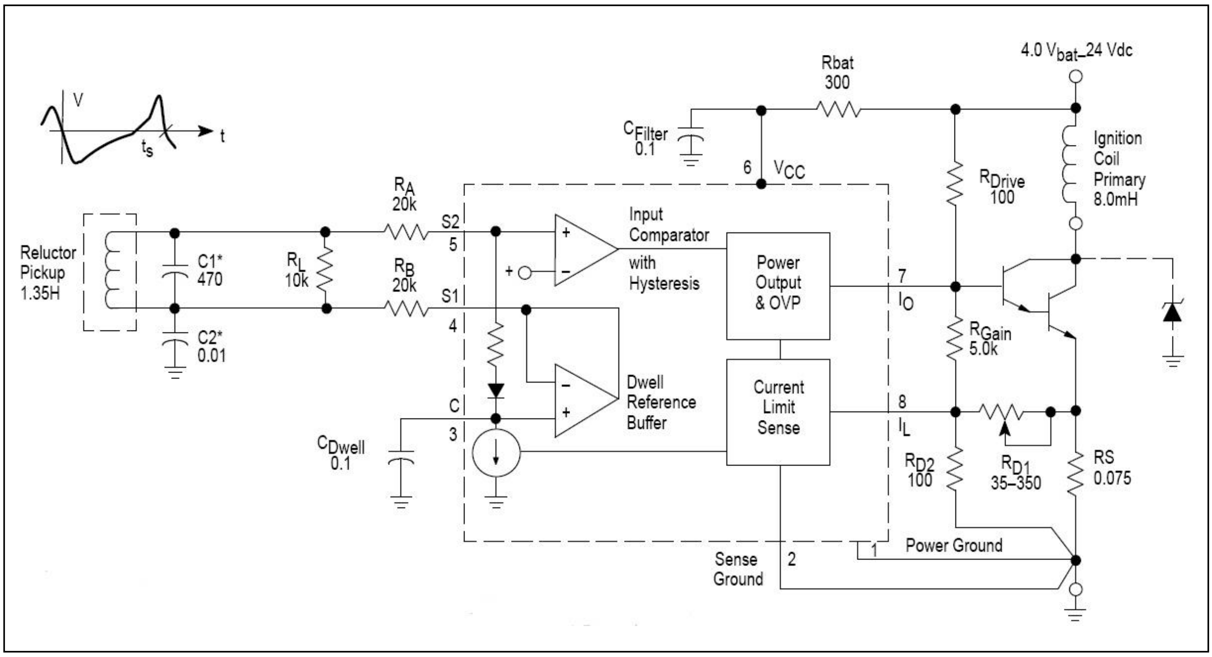
- Very Low Peripheral Component Count
- No Critical System Resistors
- Wide Supply Voltage Operating Range (4.0 V to 24 V)
- Overvoltage Shutdown (30 V)
- Dwell Automatically Adjusts to Produce Optimum Stored Energy without Waste
- Externally Adjustable Peak Current
- Available in Chip and Flip–Chip Form
- Transient Protected Inputs and Outputs

Ordering Information

Package	Remarks
SOP8	Tubed, Reeled, Pb-free
DIP8	Tubed, Pb-free

Block Diagram

Figure 1. Block Diagram and Typical Application

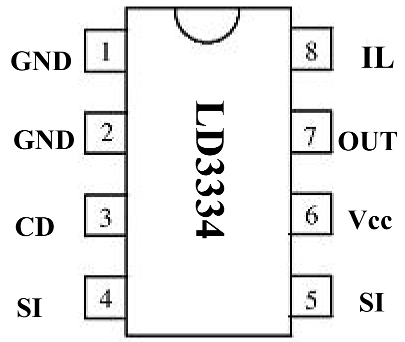


*Optional parts for extended transient protection

**A 350V zener clamp is required when using the standard power transistor.
This clamp is not required if a selected version with VCEO(sus) ≥550 V is used.

Pin Function

Pin	Symbol	Function
1	GND	Power ground
2	GND	Sense ground
3	CD	CDwell
4	SI	Start input
5	SI	Start input
6	Vcc	Power voltage
7	OUT	Power output
8	IL	Current limit sense



Maximum Ratings

Rating	Symbol	Value	Unit
Power Supply Voltage–Steady State Transient 300 ms or less	Vbat	24 90	V
Output Sink Current–Steady State Transient 300 ms or less	$I_{O(Sink)}$	300 1.0	mA A
Junction Temperature	$T_{J(max)}$	150	℃
Operating Temperature Range	T_A	-40 ~ +125	℃
Storage Temperature Range	T_{stg}	-65 ~ +150	℃
Power Dissipation, Plastic Package, Case 626 Derate above 25℃	P_D	1.25 10	W mW/℃

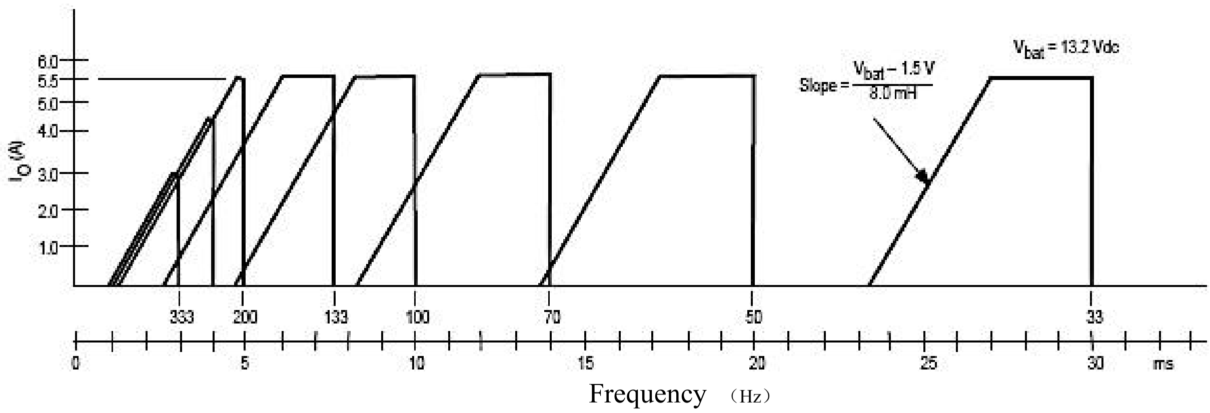


Figure 2. Ignition Coil Current versus Frequency/Period

Electrical Characteristics

(TA = –40℃ to +125℃, Vbat = 13.2 Vdc, circuit of Figure 1, unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
Internal Supply Voltage, Pin 6 Vbat = 4.0 Vdc = 8.0 = 12.0 = 14.0	Vcc		3.5 7.2 10.4 11.8		Vdc
Ignition Coil Current Peak, Cranking RPM 2.0 Hz to 27 Hz Vbat = 4.0 Vdc = 6.0 = 8.0 = 10.0	Io(pk)	3.0 4.0 4.6 5.1	3.4 5.2 5.3 5.4		A pk
Ignition Coil Current Peak, Normal RPM Frequency = 33 Hz = 133 Hz = 200 Hz = 267 Hz = 333 Hz	Io(pk)	5.1 5.1 4.2 3.4 2.7	5.5 5.5 5.4 4.4 3.4		A pk
Ignition Coil On-Time, Normal RPM Range Frequency = 33 Hz = 133 Hz = 200 Hz = 267 Hz = 333 Hz	ton		7.5 5.0 4.0 3.0 2.3	14.0 5.9 4.6 3.6 2.8	ms
Shutdown Voltage	Vbat	25	30	35	Vdc
Input Threshold (Static Test) Turn-on Turn-off	Vs2-Vs1		360 90		mVdc
Input Threshold Hysteresis	Vs2-Vs1	75			mVdc
Input Threshold (Active Operation) Turn-on Turn-off	Vs2		1.8 1.5		Vdc
Total Circuit Lag from ts (Figure 1) until Ignition Coil Current Falls to 10%			60	120	µs
Ignition Coil Current Fall Time (90% to 10%)			4.0		µs
Saturation Voltage IC Output (Pin 7) (RDRIVE = 100Ω) Vbat = 10 Vdc = 30 Vdc = 50 Vdc	VCE(sat)		120 280 540		mVdc
Current Limit Reference, Pin 8	Vref	120	160	190	mVdc

Circuit Description

The LD3334 high energy ignition circuit was designed to serve aftermarket Delco five-terminal ignition applications. This device, driving a high voltage Darlington transistor, offers an ignition system which optimizes spark energy at minimum power dissipation. The IC is pinned-out to permit thick film or printed circuit module design without any crossovers.

The basic function of an ignition circuit is to permit build-up of current in the primary of a spark coil, and then to interrupt the flow at the proper firing time. The resulting flyback action in the ignition coil induces the required high secondary voltage needed for the spark. In the simplest systems, fixed dwell angle produces a fixed duty cycle, which can result in too little stored energy at high RPM, and/or wasted power at low RPM. The LD3334 uses a variable DC voltage reference, stored on CDwell, and buffered to the bottom end of the reluctor pickup (S1) to vary the duty cycle at the spark coil. At high RPM, the LD3334 holds the output "off" for approximately 1.0 ms to permit full energy discharge from the previous spark; then it switches the output Darlington transistor into full saturation. The current ramps up at a slope dictated by Vbat and the coil L. At very high RPM the peak current may be less than desired, but it is limited by the coil itself.

As the RPM decreases, the ignition coil current builds up and would be limited only by series resistance losses. The LD3334 provides adjustable peak current regulation sensed by R_S and set by R_{D1}, in this case at 5.5 A, as shown in Figure 2. As the RPM decreases further, the coil current is held at 5.5 A for a short period. This provides a reserve for sudden acceleration, when discharge may suddenly occur earlier than expected. The peak hold period is about 20% at medium RPM, decreasing to about 10% at very low RPM. (Note: 333 Hz = 5000 RPM for an eight cylinder four stroke engine.) At lower Vbat, the "on" period automatically stretches to accommodate the slower current build–up. At very low Vbat and low RPM, a common condition during cold starting, the "on" period is nearly the full cycle to permit as much coil current as possible.

The output stage of the IC is designed with an OVP circuit which turns it on at Vbat ≈30 V (VCC ≈22 V), holding the output Darlington off. This protects the IC and the Darlington from damage due to load dump or other causes of excessive Vbat.

Component Values

Pickup Coil – series resistance = 800 Ω ± 10% @ 25℃, inductance = 1.35 H @ 1.0 kHz @ 15 Vrms

– leakage L = 0.6 mH, primary R = 0.43 W ± 5% @ 25℃,

primary L = 7.5 mH to 8.5 mH @ 5.0 A

R_L – load resistor for pickup = 10 kΩ ± 20%

R_A, R_B – input buffer resistors provide additional transient protection to the already clamped inputs = 20 k ± 20%

C1, C2 – for reduction of high frequency noise and spark transients induced in pick-up and leads; optional and non-critical

Rbat – provides load dump protection (but small enough to allow operation at Vbat = 4.0 V) = 300Ω ± 20%

C_{Filter} – transient filter on Vcc, non-critical

C_{Dwell} – stores reference, circuit designed for 0.1 uF ± 20%

R_{Gain} – R_{Gain} /R_{D1} sets the DC gain of the current regulator = 5.0 k ± 20%

R_{D2} – R_{D2} /R_{D1} set up voltage feedback from R_S

R_S – sense resistor (PdAg in thick film techniques) = 0.075Ω ± 30%

R_{Drive} – low enough to supply drive to the output Darlington, high enough to keep V_{CE}(sat) of the IC below Darlington turn–on during load dump = 100Ω ± 20%, 5.0 W

R_{D1} – starting with 35 W assures less than 5.5 A, increasing as required to set 5.5 A

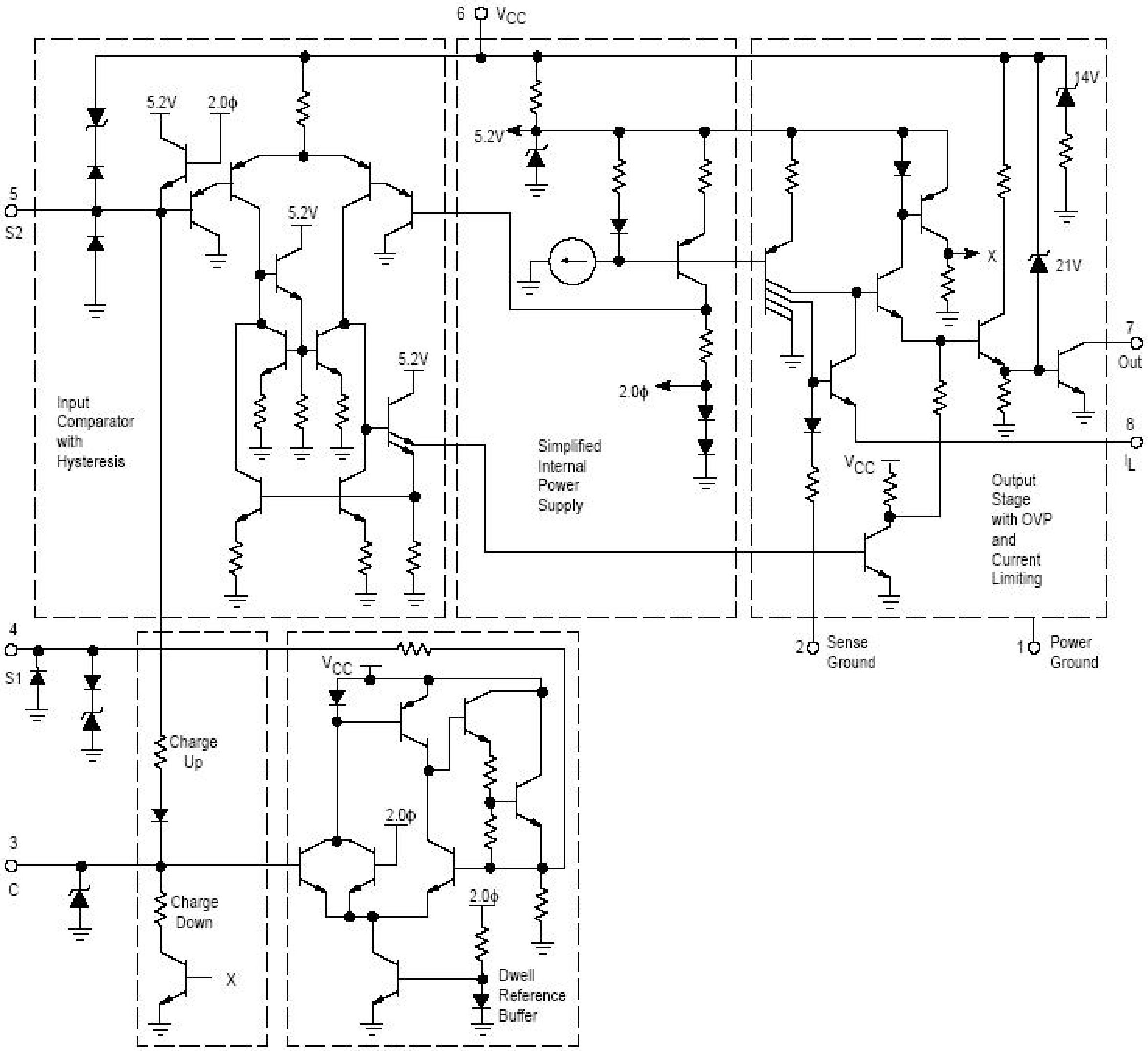
$$R_{D1} = \frac{I_{O(pk)} R_S - V_{ref}}{\frac{V_{ref}}{R_{D2}} - \frac{1.4}{R_{Gain}}} - (\approx 100\ \Omega)$$

General Layout Notes

The major concern in the substrate design should be to reduce ground resistance problems. The first area of concern is the metallization resistance in the power ground to module ground and the output to the R_{drive} resistor. This resistance directly adds to the V_{CE}(sat) of the IC power device and if not minimized could cause failure in load dump. The second concern is to reference the sense ground as close to the ground end of the sense resistor as possible in order to further remove the sensitivity of ignition coil current to ground I.R. drops.

All versions were designed to provide the same pin-out order viewed from the top (component side) of the board or substrate. This was done to eliminate conductor cross-overs. The standard LD3334 plastic device is numbered in the industry convention, counter-clockwise viewed from the top, or bonding pad side.

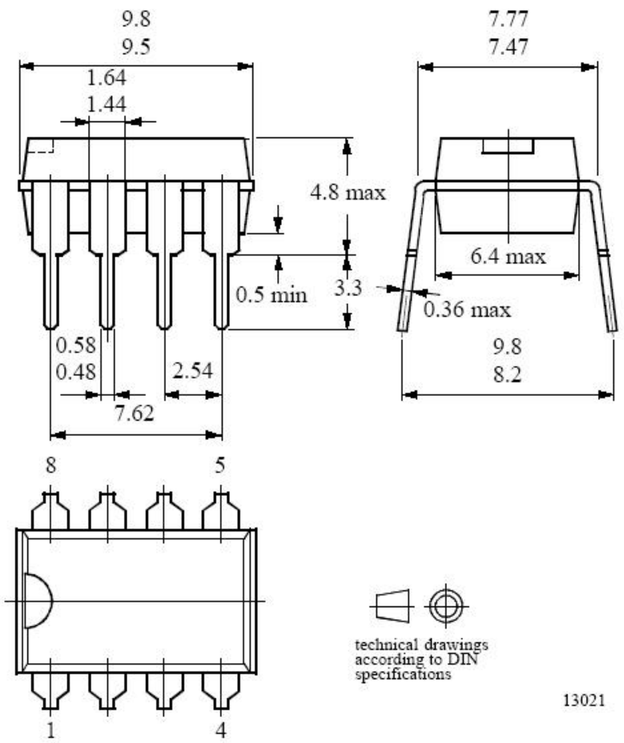
Figure 3. Internal Schematic



Package Information

DIP8

Dimensions in mm



SOP8

Dimensions in mm