

ELECTRONIC IGNITION INTERFACE

- DIRECT DRIVING OF THE EXTERNAL POWER DARLINGTON
- SEPARATE INTERFACE FOR HALL EFFECT OR INDUCTIVE SENSOR
- SEPARATE OPEN COLLECTOR BOOSTER
- COIL CURRENT PEAK VALUE LIMITER
- SIGNAL TO μP WHEN 85% AND FULL NOMINAL COIL CURRENT ARE REACHED
- CONTINUOUS COIL CURRENT PROTECTION
- EXTERNAL DARLINGTON OVERVOLTAGE PROTECTION

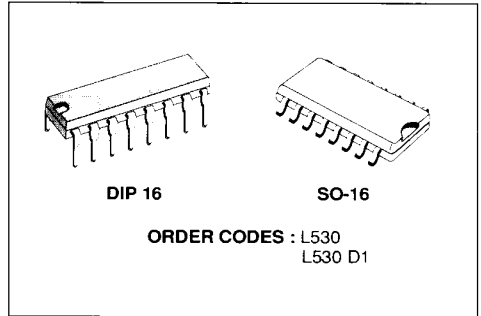
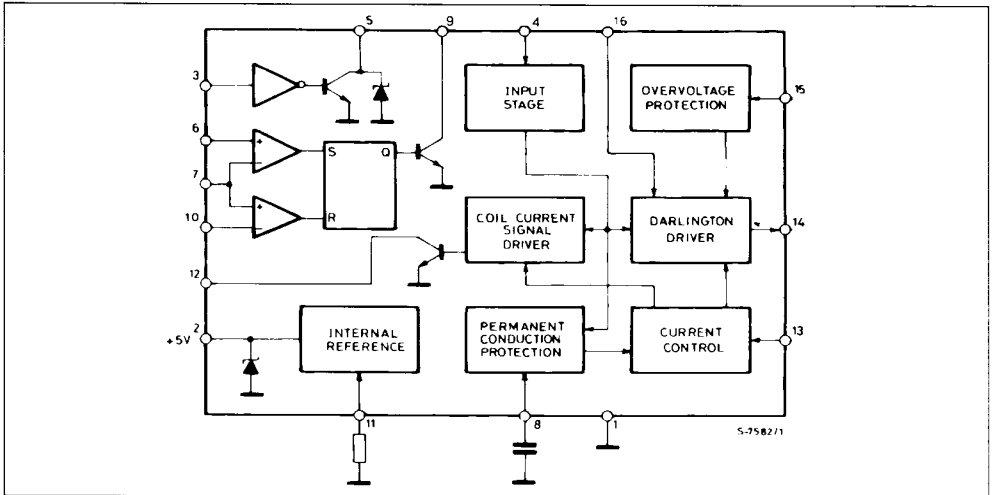
DESCRIPTION

The L530 is an integrated circuit designed for use with an NPN darlington in microprocessor controller ignition systems.

Primarily it acts as an independent controller for the current in the high voltage spark coil.

Charging of the coil is enabled under control of the micro. The device generates a feedback signal for the micro when a fixed percentage and the full nominal current into the coil are reached.

BLOCK DIAGRAM



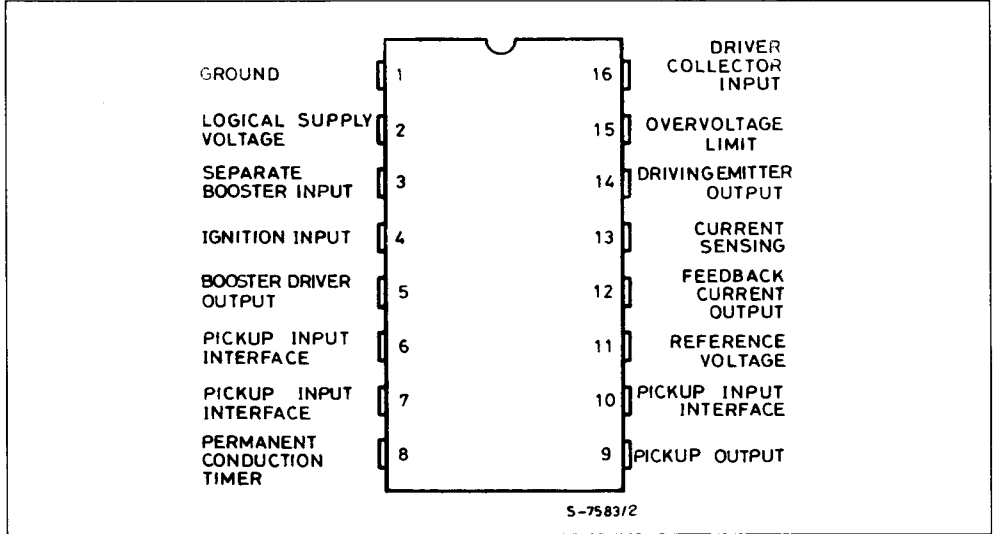
If the enable coil current input signal is active for more than a programmable time, the coil current is switched off slowly to protect the coil and avoid spurious pulses.

The L530 also contains a pulse shaper for the position sensor (both hall effect or magnetic) and an open collector booster which may be used, for example, for the RPM output.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Max. Supply Voltage (pin 16)	24	V
V_R	Reverse Battery Voltage	- 16	V
P_{tot}	Power Dissipation at $T = 90^\circ\text{C}$	1.2	W
T_{j}, T_{stg}	Junction and Storage Temperature	- 55 to 150	$^\circ\text{C}$

PIN CONNECTION (top view)



THERMAL DATA

$R_{th\ j\text{-}alumina}$ (*)	Thermal Resistance Junction-alumina for SO 16	Max	50	$^\circ\text{C}/\text{W}$
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient for DIP 16	Max	80	$^\circ\text{C}/\text{W}$

(*) Thermal resistance junction-pins with the middle of an alumina supporting substrate measuring 15x20mm ; 0.65mm thickness and infinite heatsink.

ELECTRICAL CHARACTERISTICS ($V_B = 14.4V$, $-40^\circ C \leq T_J \leq 125^\circ C$ unless otherwise specified ; referred to the application circuit of fig. 2)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_S	Operating Supply Voltage (pin 2)		4.5		5.5	V
I_S	Operating Supply Current (pin 2)	$V_S = 5V$, V_{4H}	8	13	18	mA
V_Z (*)	Internal Zener Voltage (pin 2)	$I_S = 80mA$	6	7.5	9	V
I_3	Input Current (pin 3)	$V_3 = 2V$		0	230	μA
V_{REF}	Reference Voltage at pin 11	$I_{11} = -20\mu A$	1.18	1.23	1.35	V
V_{L3}	Input Low Voltage (pin 3)				0.4	V
V_{H3}	Input High Voltage (pin 3)		2.0			V
V_{L4}	Input Low Voltage (pin 4)				0.4	V
V_{H4}	Input High Voltage (pin 4)		2.0			V
V_{SENS}	Current Limit. Sensing Voltage (pin 13)		210	260	310	mV
V_{CESat}	Series Darlington Driver Sat. Voltage (pin 16-14).	$I_O = 50mA$ $I_O = 180mA$			0.5 1.0	V V
P_{ON}	Percentage of Coil Current Determining the Feedback ON (pin 12).		75	85	90	%
V_{OVP}	Overvoltage Protect. Zener Voltage (pin 15)	$I_{OVP} = 7mA$	21	25	30	V
T_{PC}	Permanent Conduction Protection Time (**)		0.25	0.35	0.5	sec.
V_{FL}	Feedback Output Sat. Voltage (pin 12)	$V_{pin 4} = H$ $I_{pin 12} = 5mA$			1.0	V
I_{L12}	Leakage Current (pin 12)	$V_S = 5V$			10	μA
V_{ZRPM}	RPM Output Int. Zener Voltage (pin 5)	$I_Z = 20mA$	19		29	V
V_{SATRPM}	RPM Output Sat. Voltage (pin 5)	$I_{RPM} = 10mA$ $I_{RPM} = 20mA$			0.5 1.0	V V
V_{OS}	Comparator Inputs Offset Voltage (pins 6, 7, 10)				± 15	mV
I_{BIAS}	Comparator Inputs Bias Current			- 50	- 300	mA
I_{OS}	Comparator Inputs Offset Current			± 20	± 100	nA
CMR	Common Mode Range		0		$V_S - 1.6$	V
V_{PF}	Pulse Former Output Low Voltage (pin 9)	$V_{pin 6} - V_{pin 7} > 10mV$ $V_{pin 6} = V_{pin 10}$			0.8	V
I_{L9}	Pulse Former Output Leakage Current	$V_{pin 7} - V_{pin 6} > 10mV$ $V_{pin 6} = V_{pin 10}$ $V_{pin 9} = 5V$			20	μA
I_4	Output Current (pin 7)		- 650	- 380	- 180	μA
I_{L5}	Leakage Current (pin 5)	$V_S = 16V$			22	μA

(*) This parameter measurement must be considered if the IC is not directly supplied by 5V voltage regulator. In this case a suited external resistor must be used to limit pin 2 current.

(**) See Fig.4.

PIN FUNCTIONS (refer to fig. 2)

N°	Name	Function
1	GROUND	This pin must be connected to ground.
2	SUPPLY VOLTAGE	5V Supply input.
3	BOOSTER INPUT SIGNAL	Input signal to separate booster stage. This drive circuit may be used, for example, for the RPM output signal of the micro.
4	IGNITION INPUT SIGNAL	When this pin is kept low the external darlington is switched on and the current flows through the coil for all the time the input is low, being active the internal current limitation.
5	BOOSTER DRIVER OUTPUT	Open collector output signal of the separate booster circuit. The phase is the same as the input command at pin 3.
6-7	PICKUP INPUT INTERFACE	Together with pin 10, these inputs realize a separate interface stage for both hall effect or magnetic sensor. Pin 6 is the non-inverting input of the internal comparator which sets, the internal flip-flop. Pin 7 is connected both to the inverting input of the comparator setting the latch and the non-inverting input of the second internal comparator which resets the flip-flop. See fig. 4.
8	PERMANENT CONDUCT. TIMER	A capacitor C_1 connected between this pin and ground sets the delay of the permanent conduction protection in the coil current. The typical delay time value T_{PC} is given by : $T_{PC} = 17 C_1 R_{10}$ Where R_{10} is the biasing resistor at pin 11 (in $k\Omega$) and C_1 is the delay capacitor at pin 8 (in μF).
9	PICKUP OUTPUT	Open collector output from the internal flip-flop of the interface circuit for the sensor. This memory is set by the comparator connected to pin 6 and 7 and it is reset by the second comparator connected to pin 7 and 10. The output is a negative logic. See fig. 4.
10	PICKUP INPUT INTERFACE	Inverting input of the second comparator which resets the internal flip-flop of the sensor interface circuit. See pin 6 and 7 Description.
11	REFERENCE VOLTAGE	A resistor R_{10} connected between this pin and ground sets the current used for the internal references and to drive the external capacitor of the permanent conduction protection. The recommended value is 62k Ω .
12	FEEDBACK CURRENT OUTPUT	Open collector output that indicates to micro when the 85% (typ) and the full current flows through the coil. As shown in the fig. 3, this signal goes high when the fixed percentage is reached and goes low when the full programmed coil current is detected.
13	CURRENT SENSING	Connection for coil current limitation. The current is measured on the sense resistor R_{sense} and divided on R_1/R_2 . The current limitation value is given by : $I_{SENS} = 0.26 \frac{R_1 + R_2}{R_{sens} R_2}$
14	DRIVER EMITTER OUTPUT	Current driver for the external darlington. To ensure stability and precision of T_{desat} C_a and R_3 must be used. Recommended value for R_3 is 2k Ω in order not to change the open loop gain of the system. R_a may be added to C_a to obtain greater flexibility in various application situations. C_a and R_a values ranges are 1 to 100nf and 5 to 30k Ω depending on the external darlington type.

PIN FUNCTIONS (refer to fig. 2) (continued)

N°	Name	Function
15	OVERVOLTAGE LIMIT	The darlington is protected against overvoltage by means of an internal zener available at this pin and connected to pin 14. The external divider R_4/R_5 defines the limitation value given as first approximation by : $V_{ovp} = \left(\frac{22.5}{R_5} + 7 \cdot 10^{-3} \right) R_4 + 22.5$
16	DIRVER COLLECTOR INPUT	The collector current of the internal driver which drives the external darlington is supplied through this pin. The maximum current supplied through this pin. Then the external resistor R_6 limits the maximum current supplied to the base of the external darlington.

CIRCUIT OPERATION

As shown in the fig.1, the L530 is particularly suitable for use with a microprocessor as an electronic ignition interface, driving the current through the coil by means of an external darlington.

The device takes the ignition input signal (pin 4) from the microprocessor to drive the darlington, and the output active for all the time in which the input is low.

The ignition input signal (active Low) coming from the microprocessor switches on the device output stage driving the external darlington.

The peak value of the primary current flowing into the coil is limited to a predetermined level by means of a negative feedback circuit including a current sensing resistor, a comparator, the driver stage and the power switch.

An output signal, High when the current flowing into

the coil has reached 85% of the final value and Low when the full nominal current has been reached is available at pin 12. This signal is used by the microprocessor to control the dwell time. As shown in the fig. 3 three cases are possible.

In the first case the current limitation is reached ; then, when the input command goes high (spark command) the feedback to microprocessor has already gone low.

In the second case the full current is not reached (very high speed/acceleration or very low battery voltage). Then the output signal goes low together with the spark command.

In the last case a feedback pulse is not present ; this means that the 85% of the programmed current is not reached.

Figure 1 : Typical System Configuration.

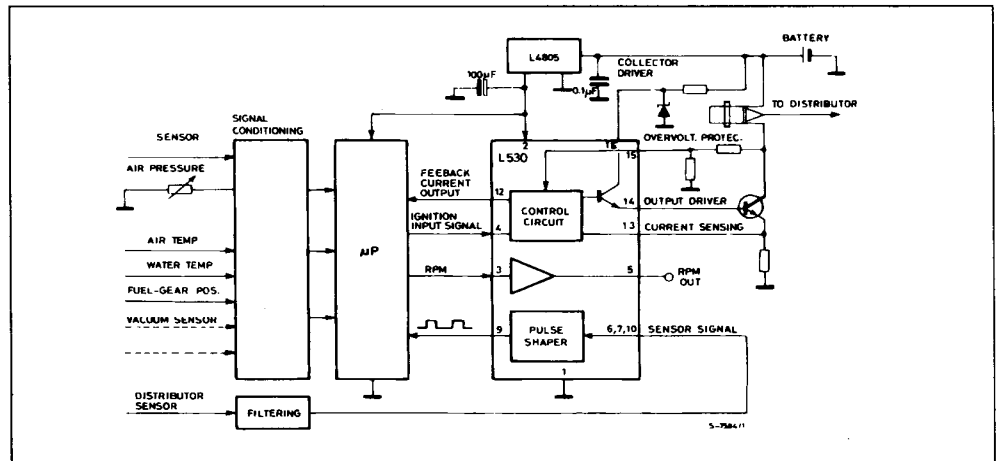


Figure 2 : Application Circuit.

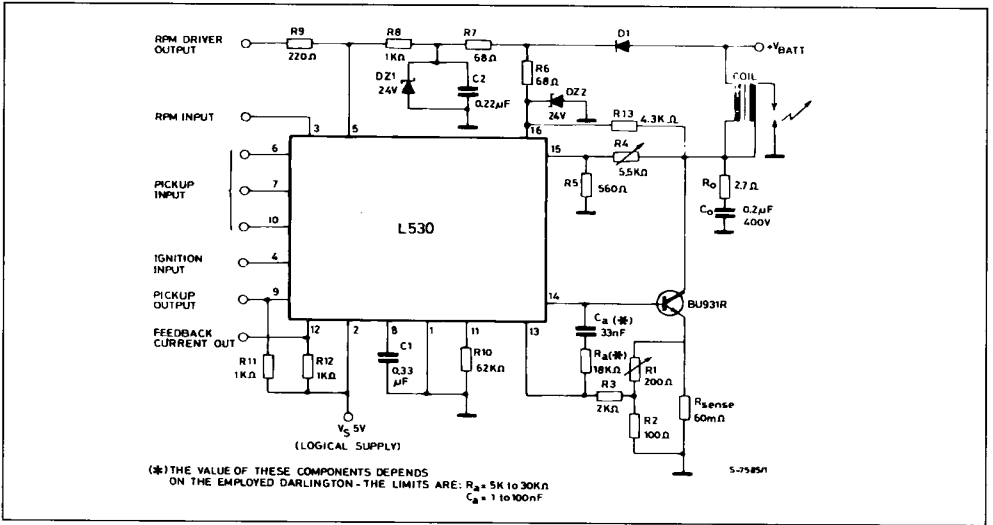
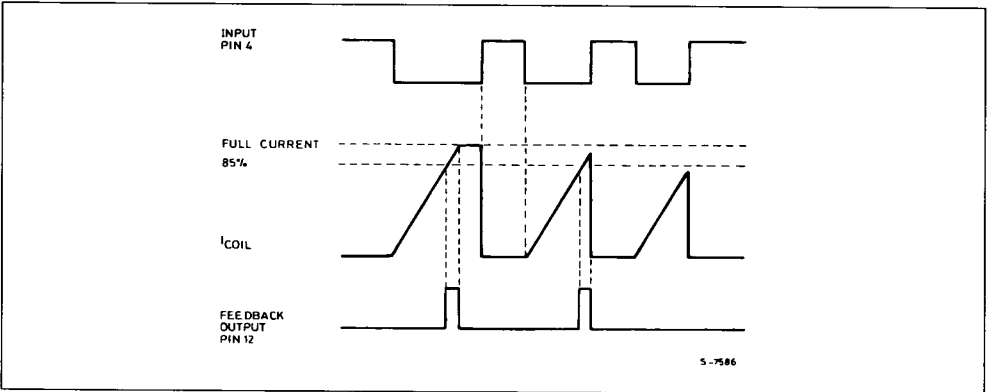


Figure 3 : Typical Operation Waveforms.



CURRENT LIMIT

The current in the coil is monitored by measuring the I_{sense} current flowing in the sensing resistor R_{sense} on the emitter of the external darlington. I_{sense} is given by :

$$I_{sense} = I_{coil} + I_{14}$$

When the voltage drop across R_{sense} reaches the internal comparator threshold value the feedback loop is activated and I_{sense} kept constant (fig. 3) forc-

ing the external darlington in the active region. In this condition :

$$I_{sense} = I_{coil}$$

When a precise peak coil current is required R_{sense} must be trimmed or an auxiliary resistor divider (R_1 , R_2) added :

$$I_{cpeak} (A) = \frac{V_{sense}}{R_{sense}} \left(\frac{R_1}{R_2} + 1 \right)$$

PERMANENT CONDUCTION PROTECTION
(fig.4)

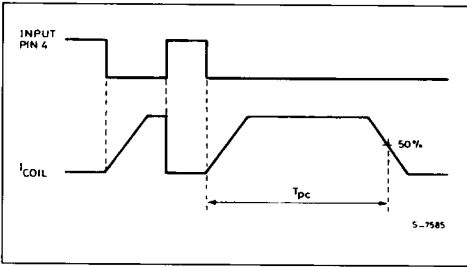
The permanent conduction protection circuit monitors the input period, charging C₁ with a constant current when the sensor signal is Low and discharging it when the sensor signal is High. If the input remains Low for a time longer than T_{PC} the voltage across C₁ reaches an internally fixed value forcing the slow decrease of coil current to zero. A low decrease is necessary to avoid undesired sparks. When the input signal goes High again C₁ is swiftly discharged and the current control loop operates normally.

The typical delay time value T_{PC} is given by :

$$T_{PC} \text{ (ms)} = 17 C_1 R_{10}$$

Where R₁₀ is the biasing resistor on pin 11 (in K ohm) and C₁ the delay capacitor at pin 8 (in uF).

Figure 4 : Permanent Conduction Protection Timing.



OTHER APPLICATION NOTES

DUMP PROTECTION

Load dump protection must be implemented by an external zener if this function is necessary. In fig. 2 DZ₂ protects the driver stage.

OVERVOLTAGE LIMITATION

The external darlington collector voltage is sensed by the voltage divider R₄, R₅. The voltage limitation increases rising R₄ or decreasing R₅.

Due to the active circuit used, an R_o C_o series network is mandatory for stability during the high voltage condition.

R_o C_o values depend on the darlington used in the application.

Moreover the resistor R₁₃ is suggested to limit the overvoltage even when supply voltage is disconnected during the high voltage condition.

REVERSE BATTERY PROTECTION

Due to the presence of external impedance at pin 5, 16, 15 L530 is protected against reverse battery voltage.

NEGATIVE SPIKE PROTECTION

If correct operation is requested also during short negative spikes, the diode D₁ and capacitor C₂ must be used.

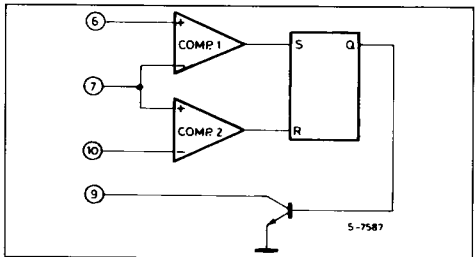
SENSOR INTERFACE

The device contains a separate pulse shaper for the sensor. As shown in fig. 5, this circuit is made by two comparators and flip-flop.

The internal flip-flop is set by the first comparator and reset by the second one. In this way it is possible to interface both the Hall effect and the magnetic pick-up sensor. Fig. 6 shows a typical solution that implements an input comparator with hysteresis able to detect the zero crossing during the input's negative edge (fig. 7). A small positive threshold guarantees the correct switch-on at low RPM.

Three pins allow the use of this interface in a wide range of configurations and, thanks to internal memory, it is possible to obtain a behaviour with hysteresis in order to have a good noise immunity.

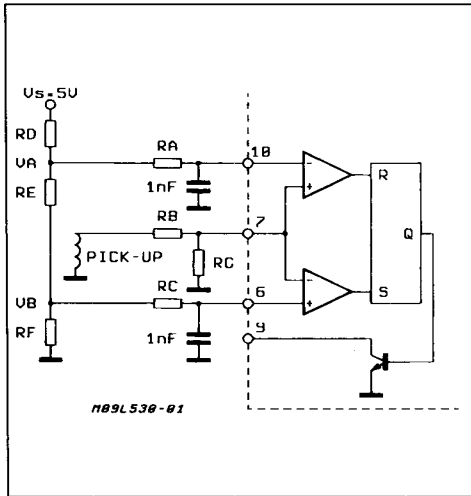
Figure 5 : Interface for Hall Effect or Inductive Sensor.



BOOSTER OUTPUT

An independent booster output is also included in the L530 to permit a separate driving stage from the microprocessor (typically employed for RPM output signal).

Figure 6 : Input Comparator with Hysteresis.



The open collector output is protected with an internal zener diode that allows the connection a un-stabilized voltage by means of a limiting resistor.

Figure 7 : Zero Crossing Detection.

