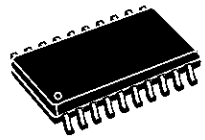
SGS-THOMSON MICROELECTRONICS

L9907N

MOTOR BRIDGE FOR HEADLIGHT ADJUSTMENT

- FULL BRIDGE OUTPUT CONFIGURATION WITH LOW SATURATION VOLTAGE LESS THAN 3.2V AT OUTPUT CURRENT 0.7A
- OPERATING SUPPLY VOLTAGE RANGE 7V TO 18V. SUPPLY OVERVOLTAGE UP TO 50V
- HIGH POSITIONING PRECISION AND HIGH NOISE IMMUNITY DUE TO TRANSFER CHARACTERISTICS WITH NEUTRAL ZONE AND STOP RANGE THRESHOLD
- FAST STOP THROUGH SHORT-CIRCUITING THE MOTOR
- MOTOR STOP STATUS IN CASE OF OPEN INPUT CONDITION
- SUPPLY OVERVOLTAGE PROTECTION FUNCTION FOR Vs MORE THAN 18V, UP TO 50V
- INPUT PROTECTION AGAINST TRANSIENTS ON THE BATTERY LINE AND THE REVERSE BATTERY CONDITION
- THERMAL OVERLOAD PROTECTION
- ESD PROTECTED ACCORDING TO MIL883C



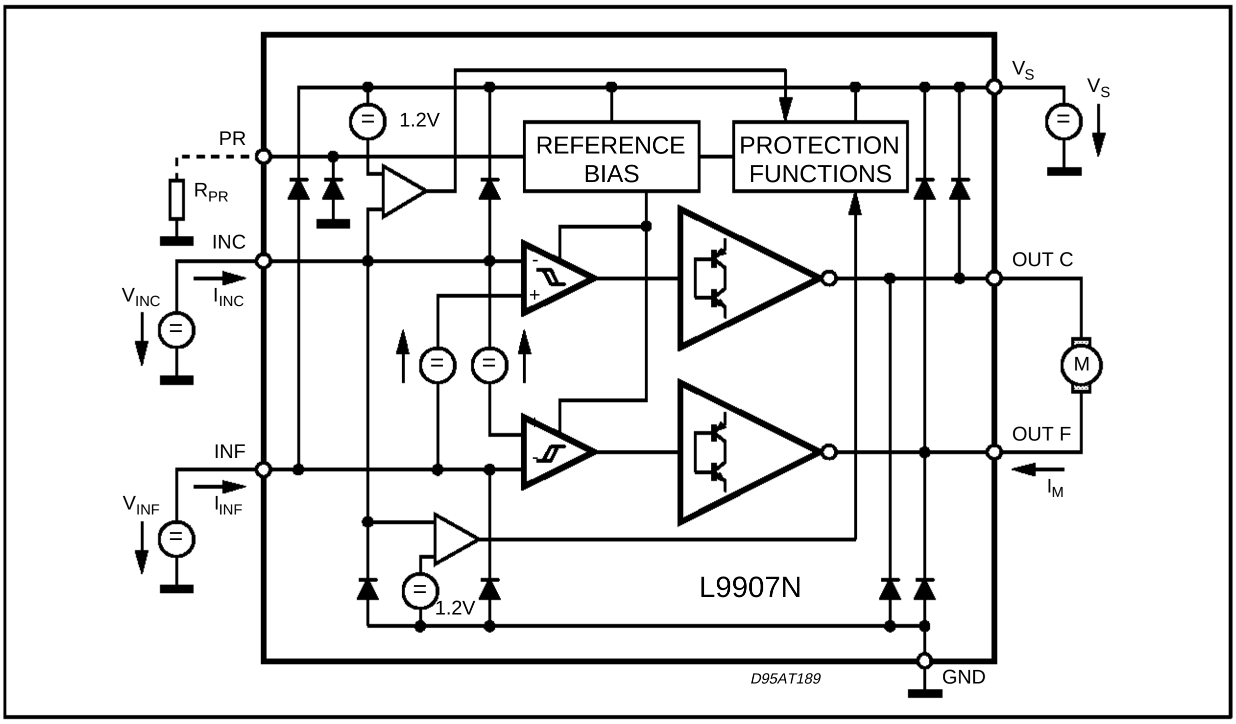
SO20L(12+4+4)

ORDERING NUMBER: L9907ND (SO20L)

DESCRIPTION

The L9907N is a monolithic integrated power comparator with full bridge output configuration, intended for driving DC motors in positioning systems, optimized for headlight adjustment application and respecting the automotive electronics environmental conditions.

BLOCK DIAGRAM

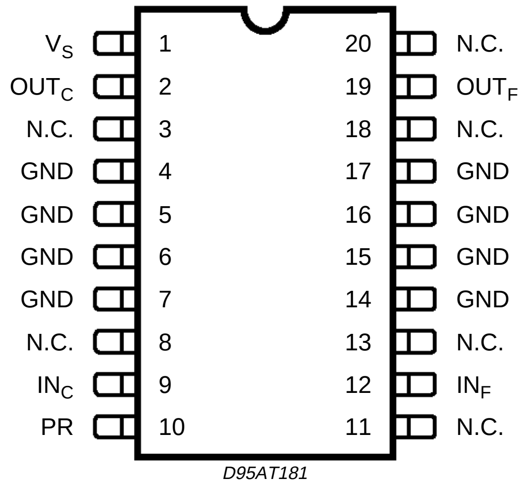


ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{SDC}	DC Supply Voltage	26	V
V_{SP}	Supply Voltage Pulse (T ≤ 400ms)	50	V
I_{OUT_DC}	DC Output Current	±0.4	A
I_{OUT_P}	Output Current Pulsed (100ms)	0.8	A
I_{IN}	DC Input Current	±10	mA
I_{IN}	Input Current Pulse (2ms)	±40	mA
T_s	Storage Shutdown Junction Temperature Range (*)	150	°C

(*) Recommended maximal T_{amb} ≤ 105°C

PIN CONNECTION



THERMAL DATA

Symbol	Parameter	SO20L	Unit
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient (1)	50	°C/W
$R_{th\ j\text{-}pins}$	Thermal Resistance Junction-pins	15	°C/W

(1) with $6cm^2$ on board heat sink area

ELECTRICAL CHARACTERISTICS ($7V \leq V_S \leq 18V$, $-40°C < T_j < 150°C$; unless otherwise specified.)

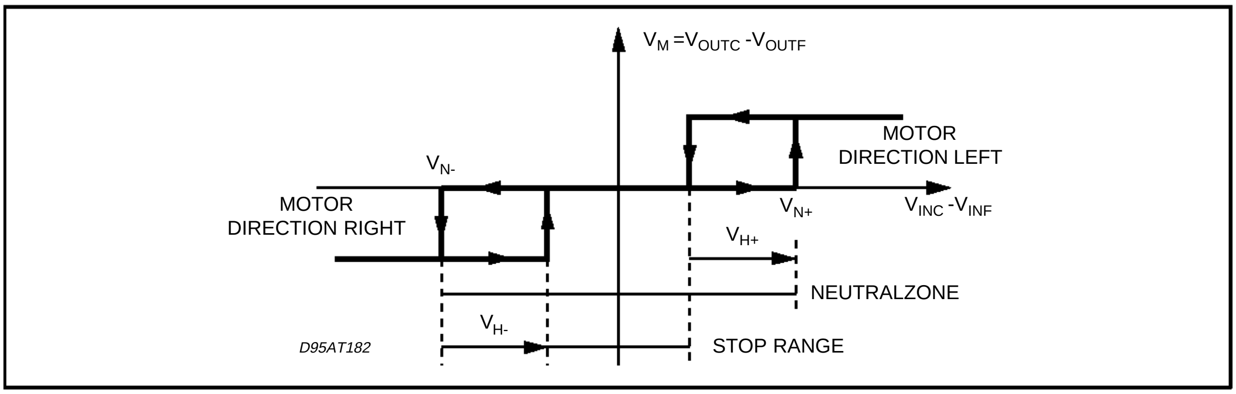
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
I_q	Quiescent Current	$I_{OUT} = 0$, (Output Open) $\lvert V_{din}\rvert < 20mV$ (stop) $\lvert V_{din}\rvert < 200mV$ (L or R)		 7 6	 9 7	 mA mA
$-V_{N-}$, V_{N+}	Neutral Zone Threshold (2)	$1.5 < V_{INC} < V_S$ -2V; $V_S = 12V$ $R_{PR} = \infty$ $R_{PR} = 0$	 3 x V_{ST} 3 x V_{ST}	 120 240	 4 x VST 4 x V_{ST}	 mV mV
$-V_{ST-}$, V_{ST+}	Stop Range Threshold	1.5 < VINC < V_S -2V; $V_S = 12V$ $R_{PR} = \infty$ $R_{PR} = 0$	 25 50	 38 76	 60 100	 mV mV
V_{INCL}	Control Input LOW Disable Threshold	T_j = -40 to +25ºC T_j = >25ºC	0.8 0.6	1.2 1.2	1.5 1.5	V V
V_{INCH} V_{CH} (3)	Control Input HIGH Disable Threshold (4)	Outputs = ON with RINC = 0Ω with R_{INC} = 5KΩ with R_{INC} = 10KΩ			 V_S-2 V_S-1.5 V_S-1.4	 V V V
		Outputs = OFF with R_{INC} = 0Ω with R_{INC} = 5KΩ with R_{INC} = 10KΩ	 V_S-0.8 V_S-0.6 V_S-0.4			 V V V
I_{IN}	Input Bias Current	$1.5 < V_{INC} < V_S$ -2V; $V_S = 12V$ $V_{din} = 0$; $R_{PR} = \infty$ $V_{din} = \pm 200mV$; $R_{PR} = \infty$ $V_{din} = 0$; $R_{PR} = 0$ $V_{din} = \pm 200mV$; $R_{PR} = 0$		 0.45 0.9 0.8 1.5	 2.0 4.0 3.6 6.8	 µA µA µA µA
V_{OSI}	Output Saturation Voltage Sink Stage	I_{OUT} = 0.7A I_{OUT} = 0.35A		1.1 0.8	1.4 1.1	V V
V_{OSO}	Output Saturation Voltage Source Stage	I_{OUT} = 0.7A I_{OUT} = 0.35A		1.2 0.9	2 1.5	V V

(2) With a programming resistor R_{PR} between the PR pin and GND the N+ and N- thresholds can be adjusted from the nominal value ($R_{PR} = \infty$, pin PR open) up to two times the nominal value ($R_{PR} = 0$, pin PR shorted to GND).

The formula defining V_{N+}, V_{N-} typical value as a function of R_{PR} and V_S is: $-V_{N-} = V_{N+} = (36mV + 0.017 \cdot V_S) \cdot \dfrac{1 + \frac{R_{PR}}{9.5K\Omega}}{1 + 2 \cdot \frac{R_{PR}}{9.5K\Omega}}$.

for $R_{PR} = \infty$ this formula reduced to:
$-V_{N+}$ ($R_{PR} = \infty$) = V_{N+} ($R_{PR} = \infty$) = 18mV + 0.0086 · V_S.
for V_s in V and R_{PR} in KΩ these formulas result in mV
(3) V_{CH} is the control input voltage applied to the pin I_{NC} through a serial resistor R_{INC}
(4) OUTPUTS = UNDEFINED for: V_S -2V < V_{CH} (R_{INC} = 0Ω) < V_S -0.8V
V_S -1.5V < V_{CH} (R_{INC} = 5KΩ) < V_S -0.6V
V_S -1.4V < V_{CH} (R_{INC} = 10KΩ) < V_S -0.4V

Figure 1: L9907N Differential Input to Output Transfer Characteristics



FUNCTIONAL DESCRIPTION

The L9907N is a power comparator with full-bridge push-pull outputs, intended for driving a DC motor in the headling adjustment system.

The basic function of the device is shown in the input-output tranfer characteristic, Fig. 1.

For differential input voltage (V_{INC} - V_{INF}) lower than the negative NEUTRAL ZONE threshold, V_{N-} the output voltage is negative (corresponds to motor direction right), for increasing differential input voltage, this status changes to the zero output voltage (motor is actively braked), when the differential input voltage exceeds the V_{ST-} stop range threshold. The output status remains in this condition as long as the differential input voltage remains within the NEUTRAL ZONE. If the input voltage increases above the positive NEUTRAL ZONE threshold V_{N+}, the output voltage become positive (motor direction left).
Similar behaviour is obtained for decreasing the input voltage. The output status transitions are marked with the arrows showing the corresponding direction of the output status variation. The active braking mode is got with both outputs in "HIGH" status
The above described behaviour assures high positioning precision, corresponding to the STOP RANGE and high noise immunity in the adjusted condition due to the NEUTRAL ZONE hysteresis thresholds.
Both the above described thresholds are defined referring to I_{NC}, I_{NF} pins. The error due to voltage drop over the input signal source resistances R_{INC}, R_{INF} is minimized with extremely low input bias currents I_{INC}, I_{INF}.
The above mentioned resistors (R_{INC}, R_{INF}) are necessary for the input current limitation during the transients on the V_{BAT} line. The input source resistors must be dimensioned so that in case of a line transient the input current in the input pin, clamped with the internal input protection diodes do not increase over the specified absolute maximum value.

Figure 2: Control to feedback transfer characteristic for tracking regulation ($V_F = V_C$ within the nominal V_{INC} operating range):

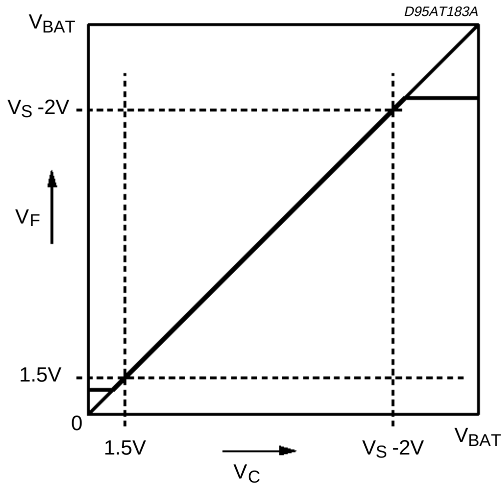
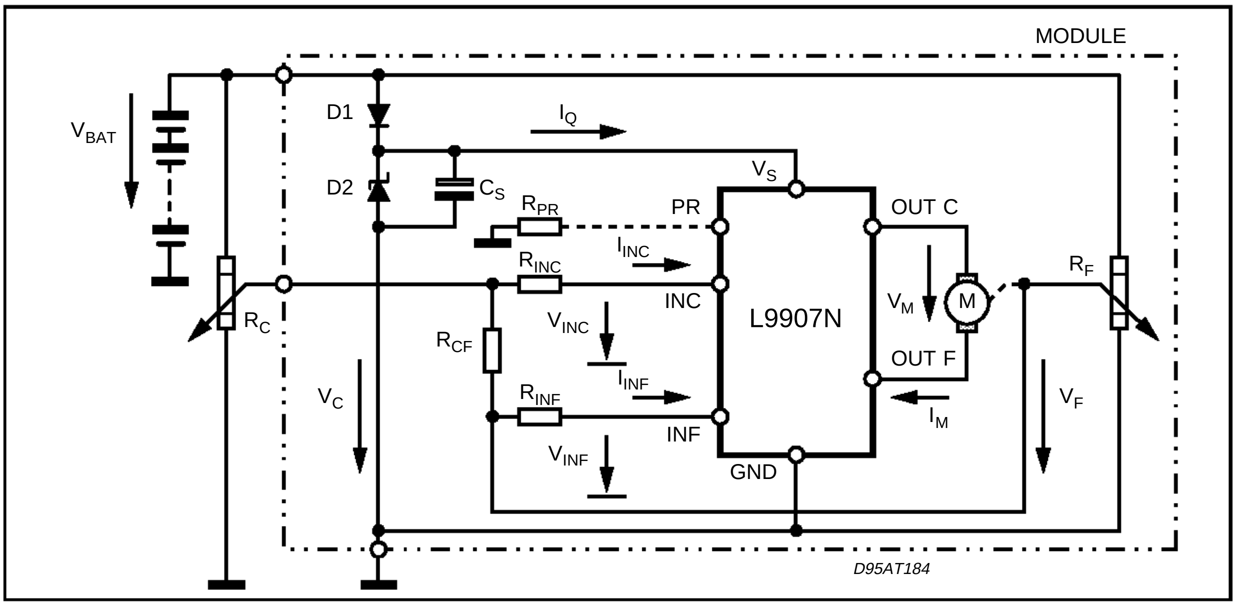


Figure 3: Recommended Application Circuit Diagram with L9907N for tracking regulation ($V_F = V_C$ for 1.5V < V_C < V_S -2V):



Note:
Recommended value of R_{INC}, R_{INF} (equivalent input resistance to I_{NC} and I_{NF}) is 5KΩ to 10KΩ. Resistor R_{CF} should assure that the differential input voltage $|V_{INC} - V_{INF}|$ remains within the NEUTRAL ZONE, when the control signal wire become broken. When this condition is fulfiled the motor will not change its previous position.

An external resistor R_{CF} is recommended between the slider of the control and feedback potentiometer.

This resistor assures that in the case of input control or input feedback wire interruption the input differential voltage will be within the NEUTRAL ZONE and the motor position remains frozen.
The circuit features an overvoltage disable function referred to the supply voltage V_S higher than 18V, both outputs are forced to tristate in this condition.

The thermal overload function disables the outputs (tristate) when the junction temperature increases above the thermal shutdown threshold temperature of min. 150°C.

For the start of a heavy loaded motor, if the motor current reaches the max. value it is necessary to respect the dynamical thermal resistance junction to ambient. The maximum output current is 0.8A.

The maximum junction temperature in this phase should not increase above the thermal shutdown threshold. In case of output disable due to thermal overload the output remains disabled till the junction temperature decreases under the thermal enable threshold. This behaviour is assured with the thermal shutdown hysteresis threshold , which minimum value is 20°C.

Figure 3, 5 and 7 show typical application diagrams for headlight adjustment applications. To assure the safety of the circuits in the reverse battery condition a reverse protection diode D_1, is necessary.

The input currents in this condition are limited by the resistors R_{INC} and R_{INF}. The transient protection diode D_2 must assure that the maximum rating for V_S during the transients at V_{BAT} line will be limited to a value lower than absolute maximum

Figure 4: Control to feedback transfer characteristic for proportional regulation with extended V_C operating range:

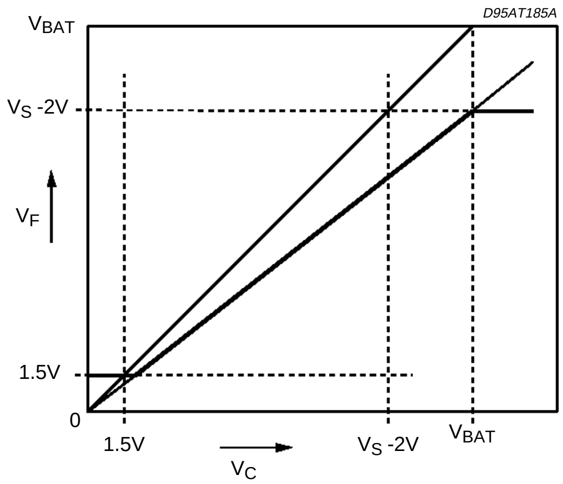
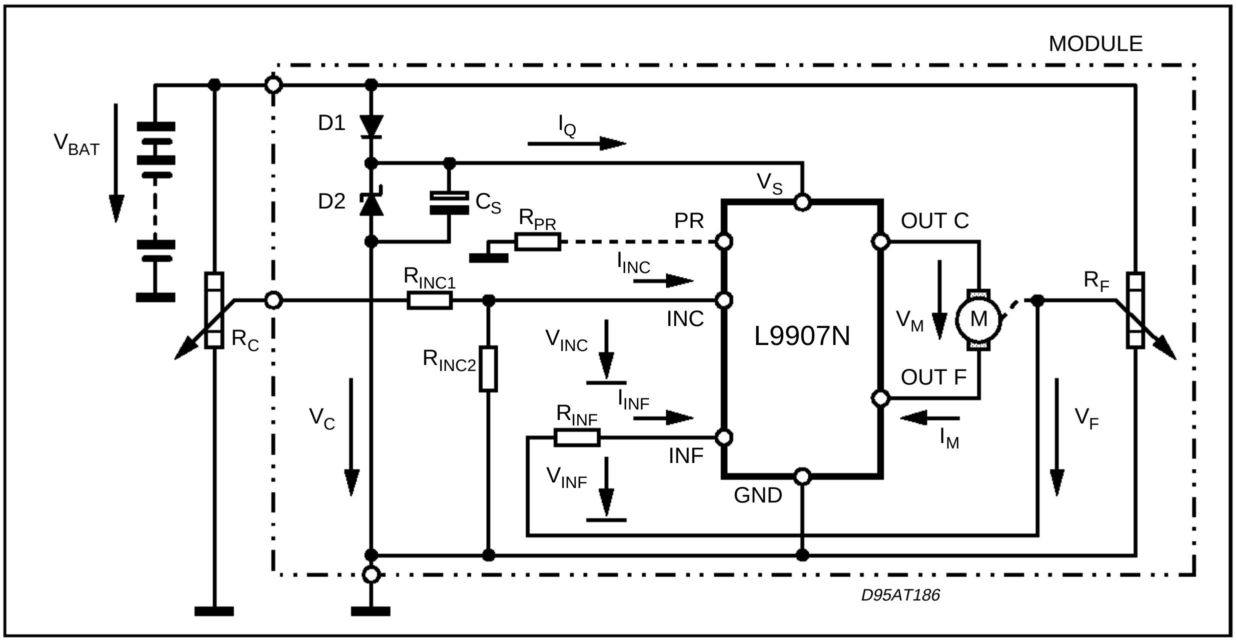
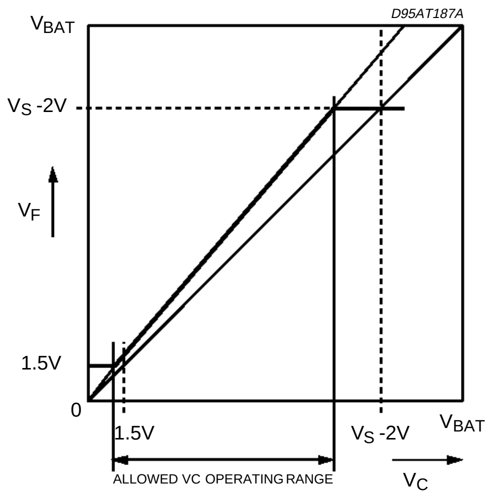


Figure 5: Recommended Application Circuit Diagram with L9907N for proportional regulation with extended V_C operating range. For ideal adjusted condition $V_F = \frac{R_{INC2}}{R_{INC1} + R_{INC2}} \cdot V_C$:



Note:
Recommended value of R_{INC}, R_{INF} (equivalent input resistance to I_{NC} and I_{NF}) is 5KΩ to 10KΩ. If the motor should not change its position, when the control signal wire become open, R_{INC1} and R_{INC2} should be rated so that $V_{INC} \leq 0.4V$ in this condition.

Figure 6: Control to feedback transfer characteristic for proportional regulation with reduced V_C operating range:

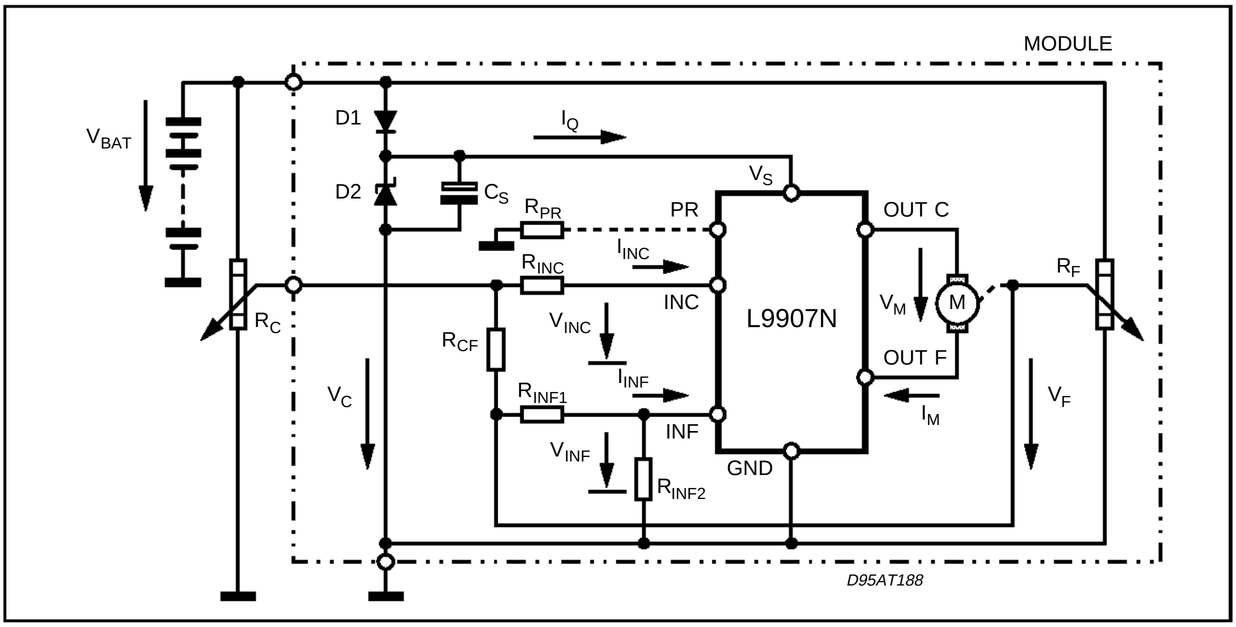


rating for V_S. The device features an output disable function in case of control input voltage overdrive.

When the control input voltage increases above the HIGH control input disable threshold $V_{INC} \geq V_{INCH}$, typically V_S -1.2V or decreases below the LOW control input disable threshold $V_{INC} \geq V_{INCH}$, typically 1.2V, then both outputs will be forced to tristate.

The potential of the INC pin is clamped at the Control Input HIGH disable threshold potential with a series resistor of 5KΩ typ. To activate the HIGH disable comparator an input current of 35µA typ. is needed. To respect this behaviour in the application V_{CR} is specified for different R_{INC}.

Figure 7: Recommended Application Circuit Diagram with L9907N for proportional regulation with reduced V_C operating range. For ideal adjusted condition $V_F = \frac{R_{INF2}}{R_{INF2} + R_{INF2}} \cdot V_C$:



Note:
Recommended value of R_{INC}, R_{INF} (equivalent input resistance to I_{NC} and I_{NF}) is 5KΩ to 10KΩ. Resistor R_{CF} should assure that the differential input voltage $|V_{INC} - V_{INF}|$ remains within the NEUTRAL ZONE, when the control signal wire become broken. When this condition is fulfilled the motor will not change its previous position.

SO20 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			2.65			0.104
a1	0.1		0.3	0.004		0.012
a2			2.45			0.096
b	0.35		0.49	0.014		0.019
b1	0.23		0.32	0.009		0.013
C		0.5			0.020	
c1	45° (typ.)					
D	12.6		13.0	0.496		0.512
E	10		10.65	0.394		0.419
e		1.27			0.050	
e3		11.43			0.450	
F	7.4		7.6	0.291		0.299
L	0.5		1.27	0.020		0.050
M			0.75			0.030
S	8° (max.)