SGS-THOMSON MICROELECTRONICS

VB100

HIGH VOLTAGE DUTY CYCLE CONTROLLER

ADVANCE DATA

- INTEGRATED 450V POWER DARLINGTON
- OUTPUT CURRENT UP TO 5A
- HIGH IMPEDANCE DIFFERENTIAL INPUTS
- PROGRAMMABLE DRIVER CURRENT
- DUTY CYCLE CONTROL LINEARITY WITHIN 1.5%
- SWITCHING FREQUENCY UP TO 100 kHz
- THERMAL PROTECTION
- INTEGRATED PROTECTION AT COMPARATOR INPUTS
- MINIMUM EXTERNAL COMPONENT COUNT

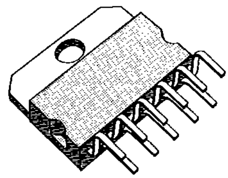
The VB100 is a monolithic integrated circuit which acts as a fully independent duty cycle controller with high voltage, high current open collector darlington output.

It is made using the innovative VI Power M1 technology merging a high voltage vertical discrete Darlington transistor together with bipolar control circuitry.

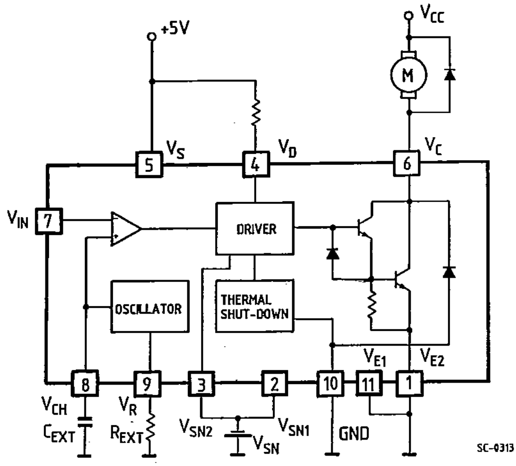
The VB100 is mainly intended as a D.C. motor and high voltage inductive load driver. It is able to adjust the output voltage duty cycle as a function of the input control voltage, at a switching frequency set by an internal stable sawtooh generator.

Built in thermal shut down switches off the power Darlington whenever the junction temperature exceeds an internally set value, typically 150°C with a 5V supply.

MULTIWATT-11



TEST AND APPLICATION CIRCUIT



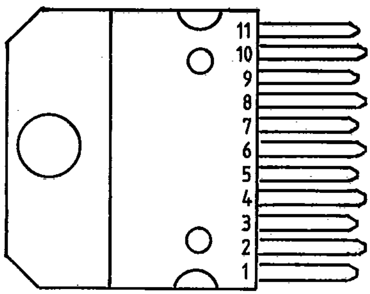
ABSOLUTE MAXIMUM RATINGS

V_{CE}	Power Darlington collector voltage	450	V
I_C	Power Darlington collector current	8	A
V_D	Driver stage supply voltage	15	V
V_S	Control stage supply voltage	15	V
I_D	Driver stage current	350	mA
V_{IN}, V_{NI}	Comparator input voltage	V_S to −10	V
P_{tot}	Power dissipation	internally limited	
T_{op}	Junction operating temperature	−45 to 150	°C
T_{stg}	Storage temperature	−55 to 150	°C

THERMAL DATA

$R_{thj-case}$	Thermal resistance junction-case	max	3.0	°C/W

CONNECTION DIAGRAM (Top view)



TAB CONNECTED TO PIN 6

PC-0290

PIN FUNCTION

N°	NAME	FUNCTION
1	V_{E1} High voltage Darlington emitter	Output stage ground n.1. It must be short circuited with V_{E2}; if no current sensing is used, a filtering capacitor must be provided between this pin and the high voltage supply. If current sensing is required, a shunt resistor can be connected between pin V_{E1} and V_{E2} and power ground and the filtering capacitor must be connected between ground and high voltage supply.
2	V_{SN1} Signal negative supply voltage	This pin is connected to the PWM ground and to the control circuit substrate. Supply range is from 0 to −5V. The applied negative supply voltage must be the most negative voltage of the device and must be the same voltage of pin V_{SN2}.
3	V_{SN2} High current negative supply voltage	This pin is connected to the driver ground. Supply range is from 0 to −5V. An applied negative supply, speeds-up the output Darlington.
4	V_D Driver stage supply voltage	This pin supplies the base current for the darlington driver during t_{ON} (output darlington on-time) $I_{D\,(on)} = (V_S - V_{D\,(sat)})/R_D$.
5	V_S Control circuit power supply	Supply voltage input. Being the internal reference voltage taken from V_S a 5V ±5% D.C. supply is required.
6	V_C High voltage output collector	This pin is internally connected to package header. It is the high voltage open collector output.
7	V_{IN} Inverting input	Input of the PWM comparator. A D.C. value between V_{CHL} and V_{CHH} sets the output duty cycle from minimum to maximum value.
8	V_{CH} Non inverting input	Non inverting input of the PWM comparator and external capacitance pin. The capacitance C_{EXT} (togheter with R_{EXT}) fixes the sawtooth generator frequency (f_{osc}). A low leakage capacitance is necessary for a linear operation. The relationship between frequency and C_{EXT} R_{EXT} is: $f_{osc} \approx 1.1/(R_{EXT} \times C_{EXT})$
9	V_R Biasing Resistor	It fixes the current I_{ch} of the current generator which changes according to the following relation: $I_{ch} = 0.56 \times V_S/R_{EXT}$
10	GND Analog ground	It is the control circuit ground: for a reliable circuit operation only few millivolt drop (<10mV) are allowed between this pin and C_{EXT}, R_{EXT} common point.
11	V_{E2} High voltage darlington emitter	Output stage ground n 2. It must be short circuited with V_{E1}; if no current sensing is used, a filtering capacitor must be provided between this pin and the high voltage supply. If current sensing is required, a shunt resistor can be connected between pins V_{E1} and V_{E2} and power ground and a filtering capacitor must be connected between power ground and high voltage supply.

ELECTRICAL CHARACTERISTICS: V_S = 5V; V_{CC} = 300V; V_A = 2V; V_B = 0V; R_{IN} = 10kΩ; R_{EXT} = 50KΩ; R_{CC} = 88Ω; R_D = 330Ω; R_{CH} = 100Ω; T_C = T_{case} = 25°C
See fig. 1. - unless otherwise specified.

Parameters		Test Conditions		Min.	Typ.	Max.	Unit
V_{CE}	Voltage between pins 6 and 1			450			V
$I_{C\ (leak)}$	High voltage collector leakage current	V_{CC} = 350 V				1	mA
$V_{CE\ (sat)}$	Saturation voltage of the output Darlington (between pins 6 and 1)	V_B = 2 V I_C = 3 A I_C = 5 A	V_A = 0 I_D = 150 mA I_D = 250 mA		 2.5 2.7	 2.9 3.3	 V V
$V_{D\ (sat)}$	Saturation voltage between pins 4 and 1	V_B = 2 V I_D = 50 mA	V_A = 0 I_C = 2A		2.8	3.5	V
V_S	Control circuit power supply			4.75	5.0	5.25	V
$I_{S\ off}$	Control circuit current			20	30	45	mA
$I_{S\ on}$	Control circut current	V_B = 2 V	V_A = 0	2.5	6	10	mA
V_{inTHH}	PWM comparator high threshold	V_B = 2 V T_C = −40 to 130°C V_A = 0 → 3 V (rising) (see fig. 2)	V_C = 50 V	0		120	mV
V_{inTHL}	PWM comparator low threshold	V_B = 2 V T_C = −40 to 130°C V_A = 3 V → 0 (falling) (see fig. 2)	V_C = 50 V	100		260	mV
$V_{inTH(hyst.)}$	PWM comparator hysteresis	V_B = 2 V T_C = −40 to 130°C (see fig. 2)	V_C = 50 V	50		250	mV
I_{IN}	PWM comparator input bias current	V_B = 2 V T_C = −40 to 130°C	V_C = 0.3 V		1	10	μA
V_{CHH}	High level threshold sawtooth generator	V_A = 0 V → 3.2 V (rising)	V_B = 0.3 V	2.45	2.55	2.8	V
V_{CHL}	Low level threshold sawtooth generator	V_A = 3.2 V → 0 V (falling)		0.4	0.5	0.7	V
$\frac{I_{CH} - I_R}{I_R}$	External capacitor charging current, pin 8 versus I_R, pin 9	I_R = 50 to 110 μA V_A = 1 V	V_B = 0.3 V	−7		+7	%

ELECTRICAL CHARACTERISTICS:

Parameters		Test Conditions	Min.	Typ.	Max.	Unit
$\frac{I_{CH}^*}{T} \times \frac{1}{I_{CH}}$	Capacitor charging current change with temperature (pin 8)	$V_A = 1$ V $V_B = 0.3$ V $I_R = 100\ \mu A$ $T_C = -40$ to 130°C			300	ppm/°C
V_R	Reference bias voltage pin 11	$I_R = 100\ \mu A$	2.7	2.8	2.92	V
t_r	Rise time of the Darlington collector current, I_C (see fig. 3)	$I_D = 150$ mA $I_C = 3$ A		0.25		μs
t_s	Storage time of the Darlington collector current, I_C (see fig. 3)	$I_C = 3$ A $I_D = 150$ mA $V_{SN} = -5$ V $V_{SN} = 0$ V		 1.5 8.0		 μs μs
t_f	Fall time of the Darlington collector current, I_C (see fig. 3)	$I_C = 3$ A $I_D = 150$ mA $V_{SN} = -5$ V $V_{SN} = 0$ V		 0.2 1.0		 μs μs
$t_{ON\ (min)}$	Minimum duration of the Darlington collector current, I_C (see fig. 3)	$I_C = 3$ A $I_D = 150$ mA $V_{SN} = -5$ V $V_{SN} = 0$ V		 2.0 10.0		 μs μs

$I_{CH}^* = I_{CH}(130°C) - I_{CH}(-40°C)$
N.B.* pulsed operation: $t_{rep.} = 10$ ms $t_{ON} = 100\ \mu s$

Fig. 1 Test Circuit

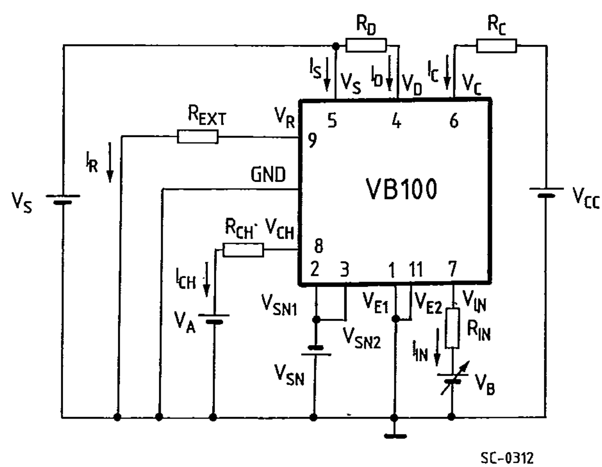


Fig. 2 Comparator threshold hysteresis

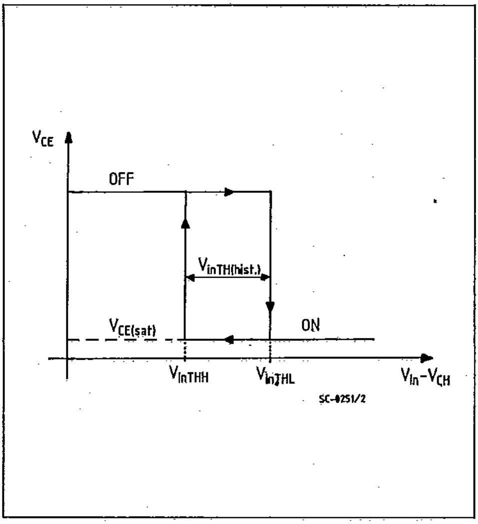


Fig. 3 Switching waveforms

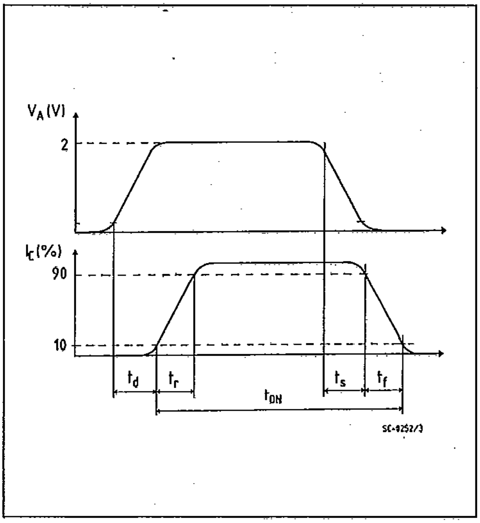
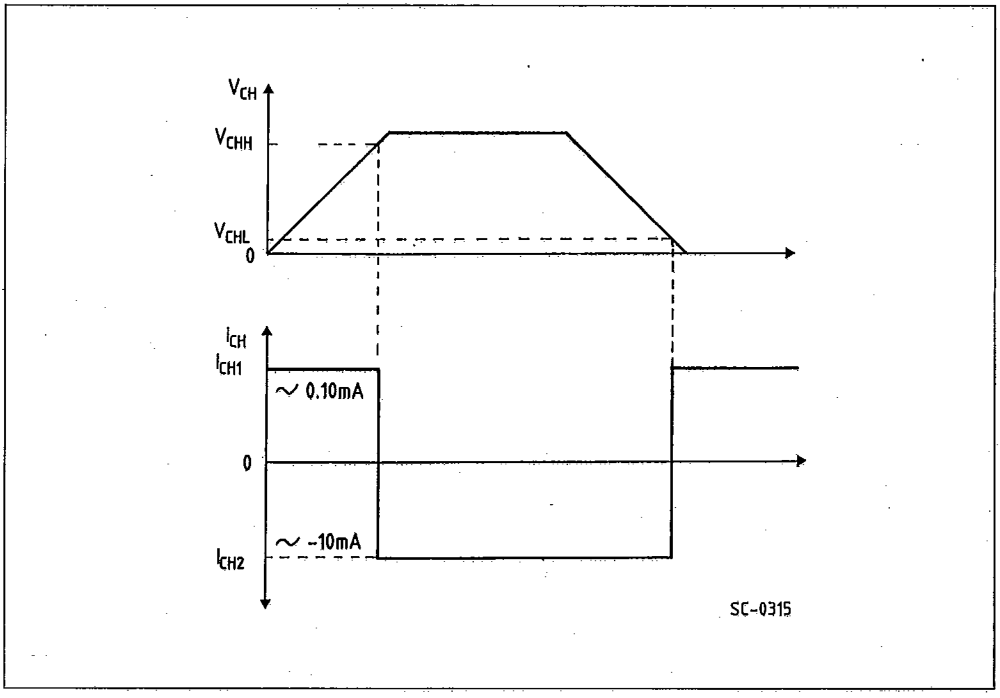


Fig. 4 Switching waveforms



APPLICATION INFORMATION

The VB100 is mainly intended as a quarter bridge controller. The sawtooth generator frequency is set by two external components, $R_{EXT.}$ and $C_{EXT.}$:

$$f_{osc} = 1.1/(R_{EXT.} \times C_{EXT.})$$

in the ranges:

23.3 kΩ	$< R_{EXT.}$	< 100 kΩ
400pF	$< C_{EXT.}$	< 200 μF
0.5 Hz	$< f_{osc.}$	< 100kHz

The input voltage V_{IN} sets the duration of t_{ON} for the output stage. As V_{IN} increases t_{ON} increases following the relationship:

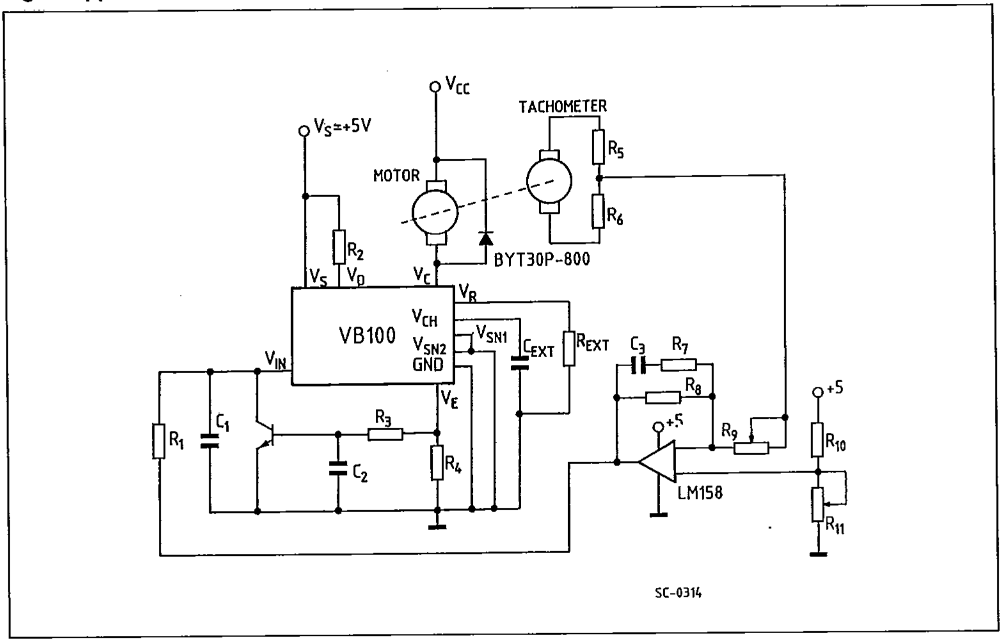
$$t_{ON} = t_s + t_f + t_r + 0.91 \times \frac{R_{EXT.} \times C_{EXT.}}{(V_{CHH} - V_{CHL})} \times V_{IN}$$

in the range:

$0.5Hz < f_{osc.} < 5\ kHz$ with $V_{SN} = 0$
$0.5Hz < f_{osc.} < 20\ kHz$ with $V_{SN} = -5\ V$

If an inductive load is used, it is necessary to provide a current limiting circuit. The device can form part of a closed loop control by just adding a few external components; fig. 5 shows a typical application example.

Fig. 5 Application Circuit



$R_1 = 100$	$R_5 = 100\ k\Omega$	$R_9 = 50\ k\Omega$	$C_1 = 1\ nF$
$R_2 = 33\ \Omega$	$R_6 = 1.8\ k\Omega$	$R_{10} = 3.3\ k\Omega$	$C_2 = 1\ nF$
$R_3 = 1\ k\Omega$	$R_7 = 2\ k\Omega$	$R_{11} = 4.7\ k\Omega$	$C_3 = 33\ nF$
$R_4 = 0.15\ \Omega$	$R_8 = 100\ k\Omega$	$R_{EXT} = 50\ k\Omega$	$C_{EXT} = 1.8\ nF$