SIEMENS

2-A DC Motor Driver

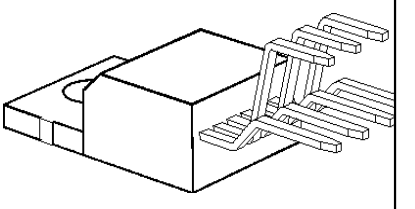
TLE 4202 B

Preliminary Data

Bipolar IC

Features

- Drives motors up to 2 A
- Integrated free-wheeling diodes 2.5 A
- Short-circuit proof to ground
- Overtemperature protection
- Low saturation voltages through bootstrap
- Wide temperature range
- Suitable for applications in automotive engineering



P-TO220-7-1

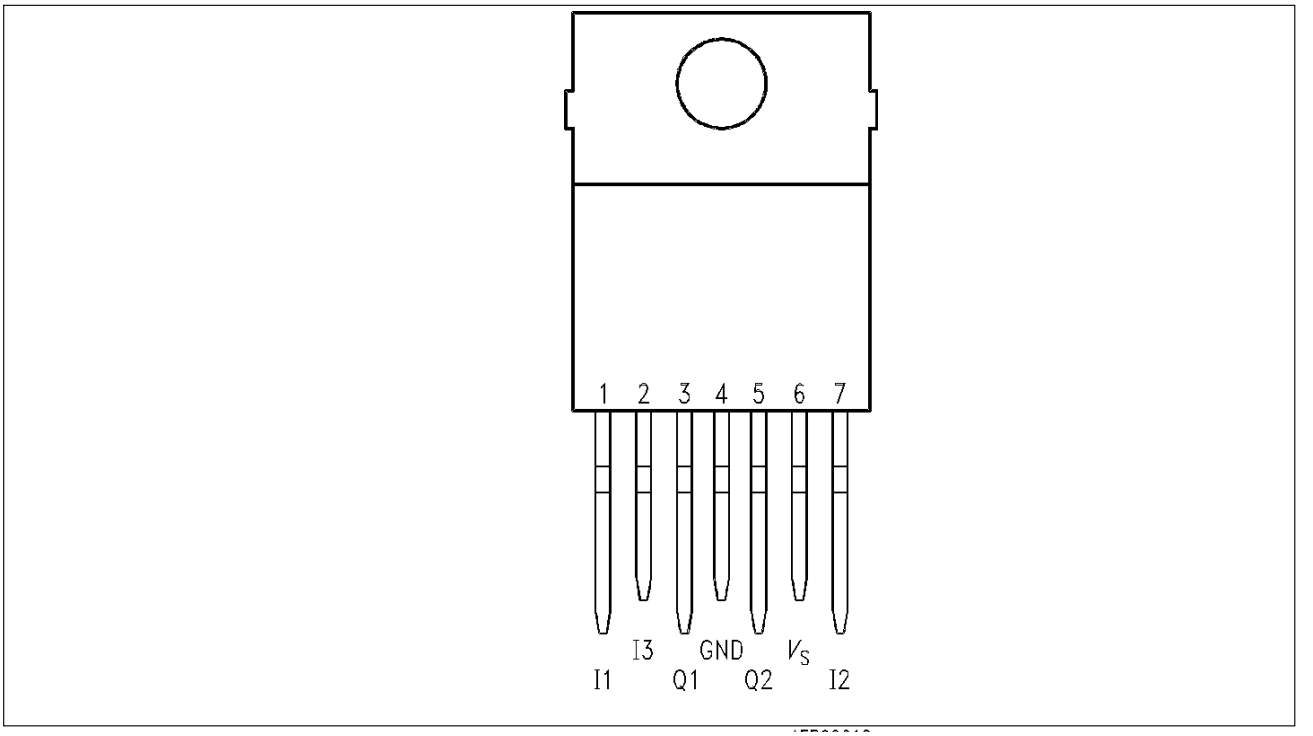
Type	Ordering Code	Package
TLE 4202 B	Q67000-A8225	P-TO220-7-1

The two power comparators can switch magnets, motors or other loads either by being separated from each other or by being combined to a full-bridge circuit. The IC is designed for application in motor vehicles. It can be applied at package temperatures between – 40 °C and 130 °C.

The IC contains two amplifiers featuring a typical open-loop voltage gain of 80 dB at 500 Hz.

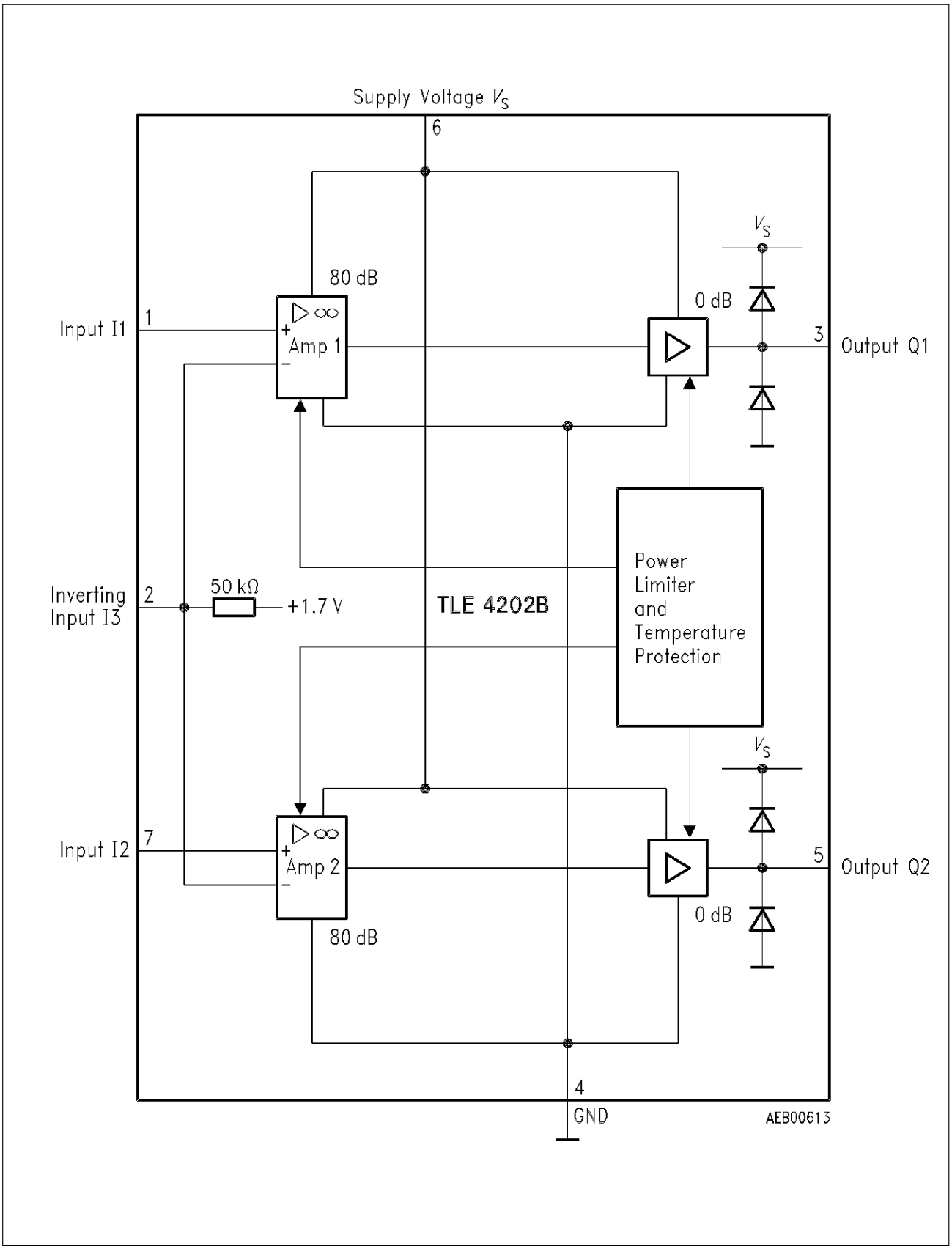
The input stages are PNP differential amplifiers thus resulting in a common-mode input voltage range from 0 V to approx. the value of V_S and in a maximum input differential voltage of V_S. To obtain low saturation voltages at the sink circuit, the drive circuit of the sink transistor is connected to the supply voltage. An SOA protective circuit protects the IC against ground short-circuits. At chip temperatures above approx. 160 °C the source transistors are turned off.

Pin Configuration
(top view)



Pin Definitions and Functions

Pin No.	Symbol	Function
1	I1	**Input 1** Non-inverting input 1, to be connected to pin 2 and pin 3 according to general rules
2	I3	**Inverting input 3** Inverting inputs of the two comparators; internally connected to reference voltage across 50 kΩ (typ. 1.7 V)
3	Q1	**Output Q1** Push-pull output B DC-short-circuit proof to ground. Integrated free-wheel diodes to ground and to supply voltage
4	GND	**Ground**
5	Q2	**Output Q2,** see pin 3
6	V_S	**Supply voltage** Has to be blocked to ground with a ceramic capacitor of at least 100 nF directly at the pins of the ICs
7	I2	**Input 2** Non-inverting input 2; see pin 1



Block Diagram

Absolute Maximum Ratings

T_C = – 40 to 130 °C

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Supply voltage	V_S	–	40	V
Output current of sink transistors $T_C \leq 85$ °C	I_Q	–	2.5	A
Output current of source transistors internally limited	I_Q	–	–	–
Diode peak currents				
to + V_S	I_{F+}	–	2.5	A
to ground	I_{F-}	–	2.5	A
Voltage at pins I1, I2, I3	$V_{1, 2, 7}$	– 0.3	V_S	V
Voltage at pins Q1, Q2 [1]	$V_{3, 5}$	–	–	V
Junction temperature	T_j	–	150	°C
Storage temperature	T_{stg}	– 55	125	°C

Operating Range

Supply voltage	V_S	3.5	17	V
Case temperature during operation	T_C			
$R_L \geq 6\ \Omega$, V_S = 7 … 16 V		– 40	–	°C
$R_L \geq 9\ \Omega$, V_S = 16 V		–	130	°C
Voltage amplification (at negative feedback with external connection)	V_V	30	–	dB
Thermal resistance system - case	$R_{th\ SC}$	–	4	K/W

[1] The output voltages are kept within a permissible range by free-wheel diodes

Outputs Q1 and Q2 short-circuit proof to ground

R_L: Resistance between output 1 and output 2

Characteristics

V_S = 13 V; T_j = 25 °C

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
General Data							
Quiescent current	I_S	–	15	25	mA	S = 1	1
Open-loop gain	G_{VO}	50	80	–	dB	f = 500 Hz $V_S \leq 7$ V ≤ 16 V T_C = – 40 °C to + 110 °°C	1
Input Characteristics							
Input current (pins I1, I2)	$I_{I\,1,\,7}$	–	1.0	3.0	µA	$V_{I\,1,\,12}$ = 0	2
Input current	$I_{I\,2}$	–	35	70	µA	$V_{I\,2}$ = 0; $V_{I\,1,\,7} = V_S$	1
	$-I_{I\,2}$	–	230	300	µA	$V_{I\,2} \leq V_S$; $V_{I\,1,\,7}$ = 0 V	–
Input resistance	$R_{I\,1,\,7}$	1	5	–	MΩ	f = 1 kHz	1
Input reference voltage	$V_{I\,2}$	1.4	1.7	2.0	V	I_2 = 0; $V_{I\,1,\,7}$ = 0 V	1
Input offset voltage	$V_{I\,0}$	– 20	–	20	mV	–	3

Characteristics (cont'd)

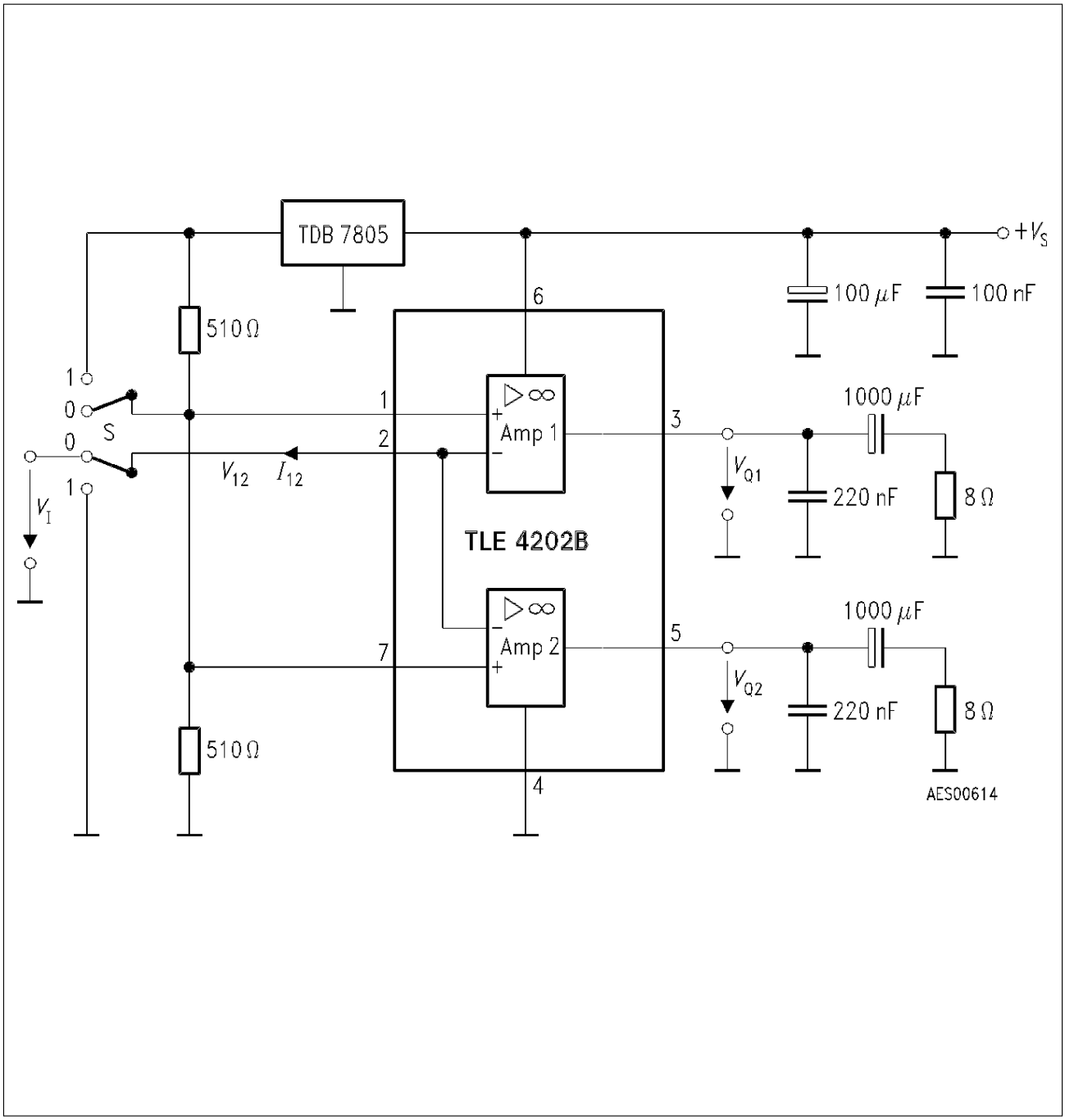
V_S = 13 V; T_j = 25 °C

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Output Characteristics							
Saturation voltages							
Source operation	V_{Sato}	–	0.9	1.0	V	I_Q = – 0.3 A; S1 = 1	2
measured to V_S	V_{Sato}	–	1.2	1.6	V	I_Q = – 1.0 A; S1 = 1	2
	V_{Sato}	–	1.5	2.1	V	I_Q = – 2 A; S1 = 1	2
Sink operation	V_{Satu}	–	0.25	0.4	V	I_Q = + 0.3 A; S1 = 2	2
			0.5	0.75	V	I_Q = + 1.0 A; S1 = 2	2
	V_{Satu}	–	1.0	1.3	V	I_Q = + 2 A; S1 = 2	2
Short-circuit current	I_{SC}	–	1.25	1.60	A	V_Q = 0 V	2
Diode forward voltage to + V_S	V_{F+}	–	1.0	1.3	V	$I_F = I_Q$ = + 1 A	2
to ground	V_{F-}	–	0.9	1.2	V	$I_F = I_Q$ = + 1 A	2
Slew rate falling edge	SR	–	6	–	V/µs	–	1
Slew rate rising edge	SR	–	6	–	V/µs	–	1
Switching Times							
Rise time of V_Q	t_r	–	1.5	–	µs	–	1
Fall time of V_Q	t_f	–	1.5	–	µs	–	1
Switch-ON delay	t_{ON}	–	3.0	–	µs	–	1
Switch-OFF delay	t_{OFF}	–	1.5	–	µs	–	1
Quiescent current	I_S	–	15	30	mA	S = 1	1

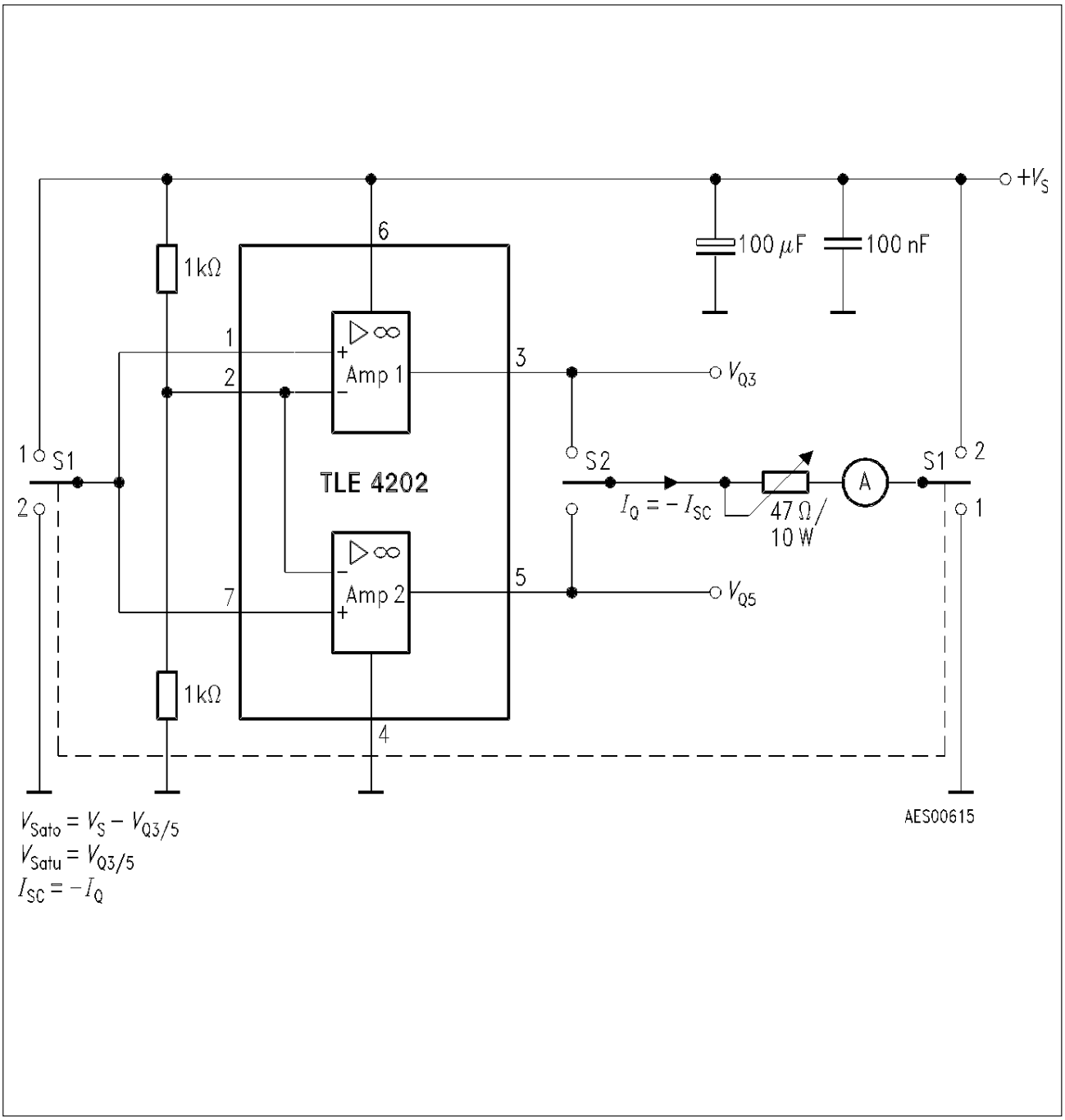
Characteristics (cont'd)

$V_S \leq 7$ V to 17 V; T_C = – 40 to 110 °C

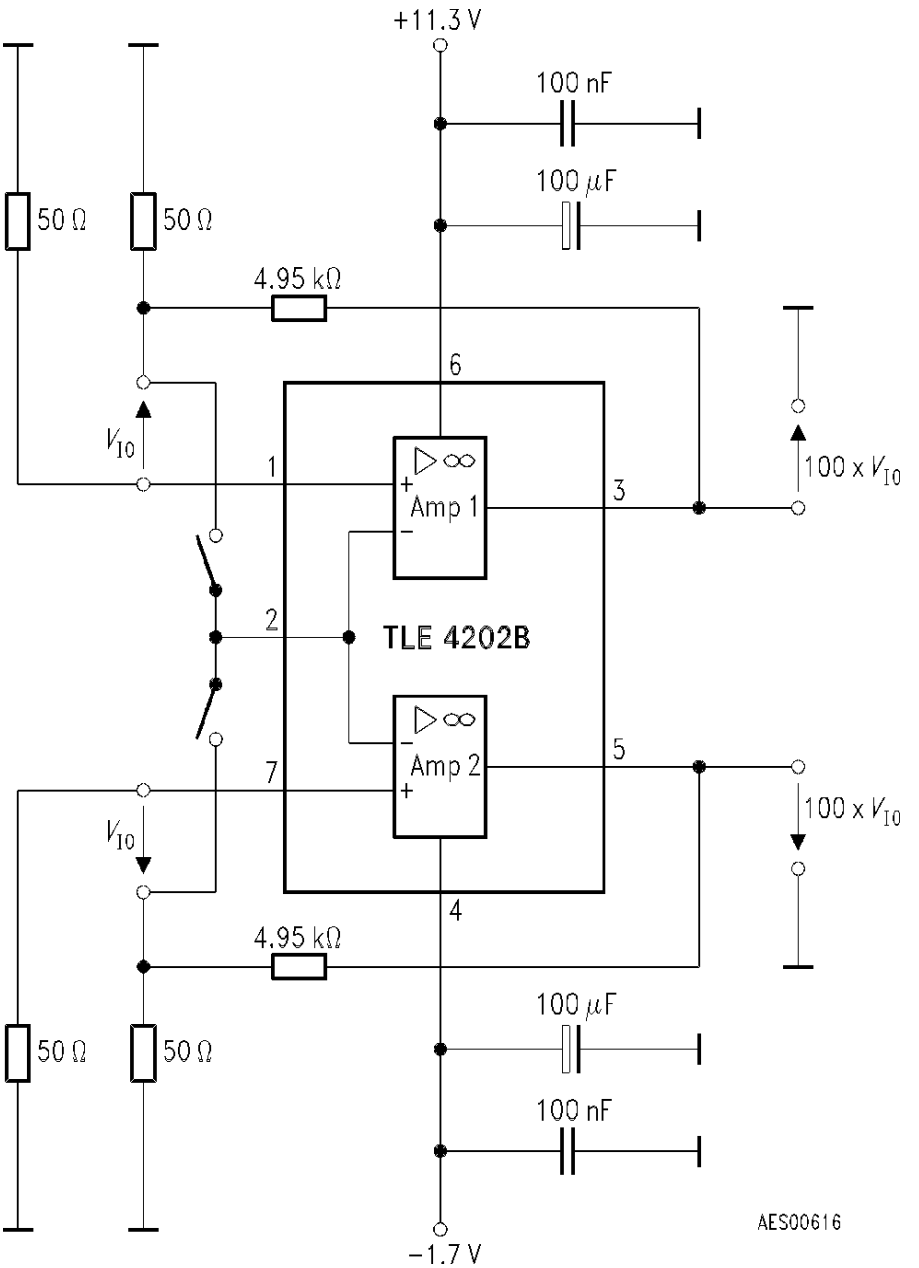
Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Saturation Voltage							
Source operation measured to V_S	V_{Sato}	–	0.9	1.2	V	I_Q = – 0.3 A; S = 1	2
	V_{Sato}	–	1.2	1.8	V	I_Q = – 1 A; S = 1	2
	V_{Sato}	–	1.5	2.4	V	I_Q = – 2 A; S = 1	2
Sink operation	V_{Satu}	–	0.25	0.60	V	I_Q = 0.3 A; S1 = 2	2
	V_{Satu}	–	0.5	1.1	V	I_Q = 1 A; S1 = 2	2
	V_{Satu}	–	1.2	2.0	V	I_Q = 2 A; S1 = 2	2
Short-circuit current	$-I_{SC}$	–	–	3.5	V	V_Q = 0 V T_C = 25 °C to 110 °C	–



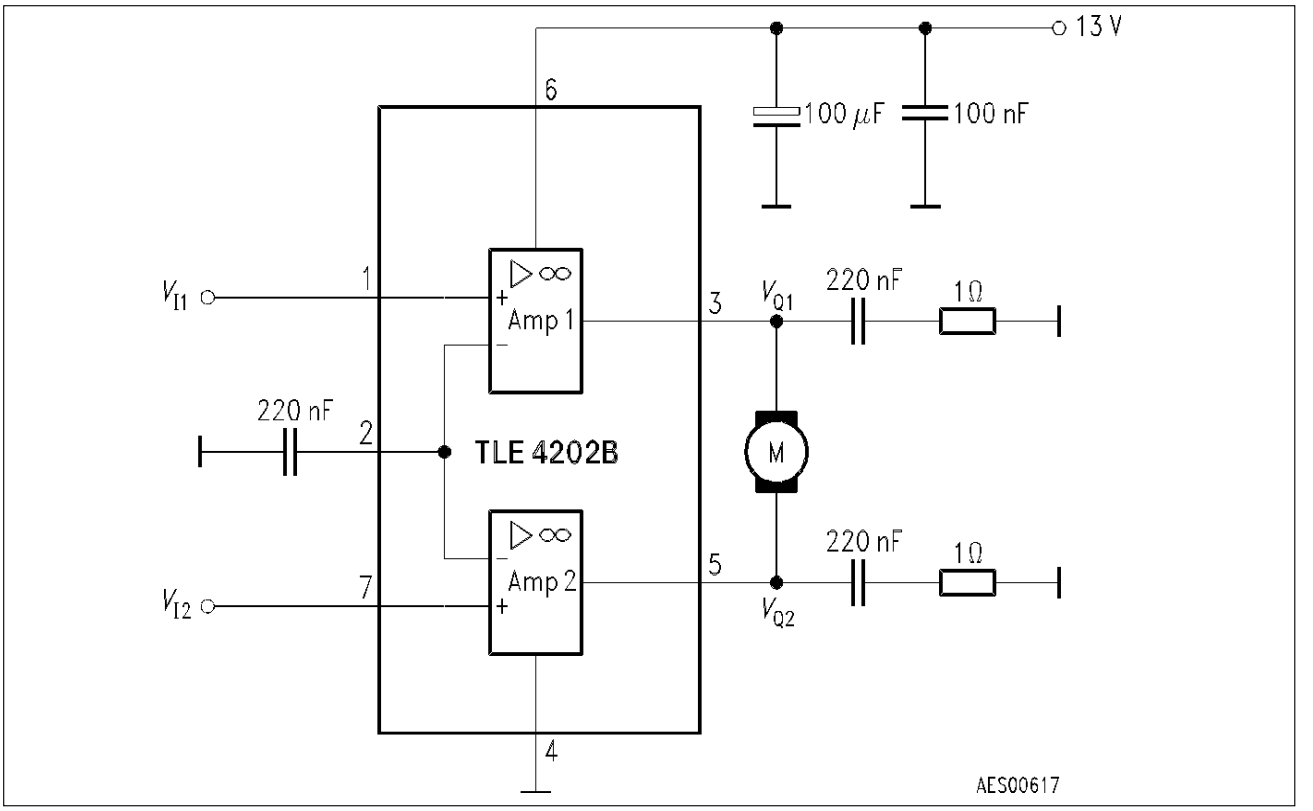
Test Circuit 1



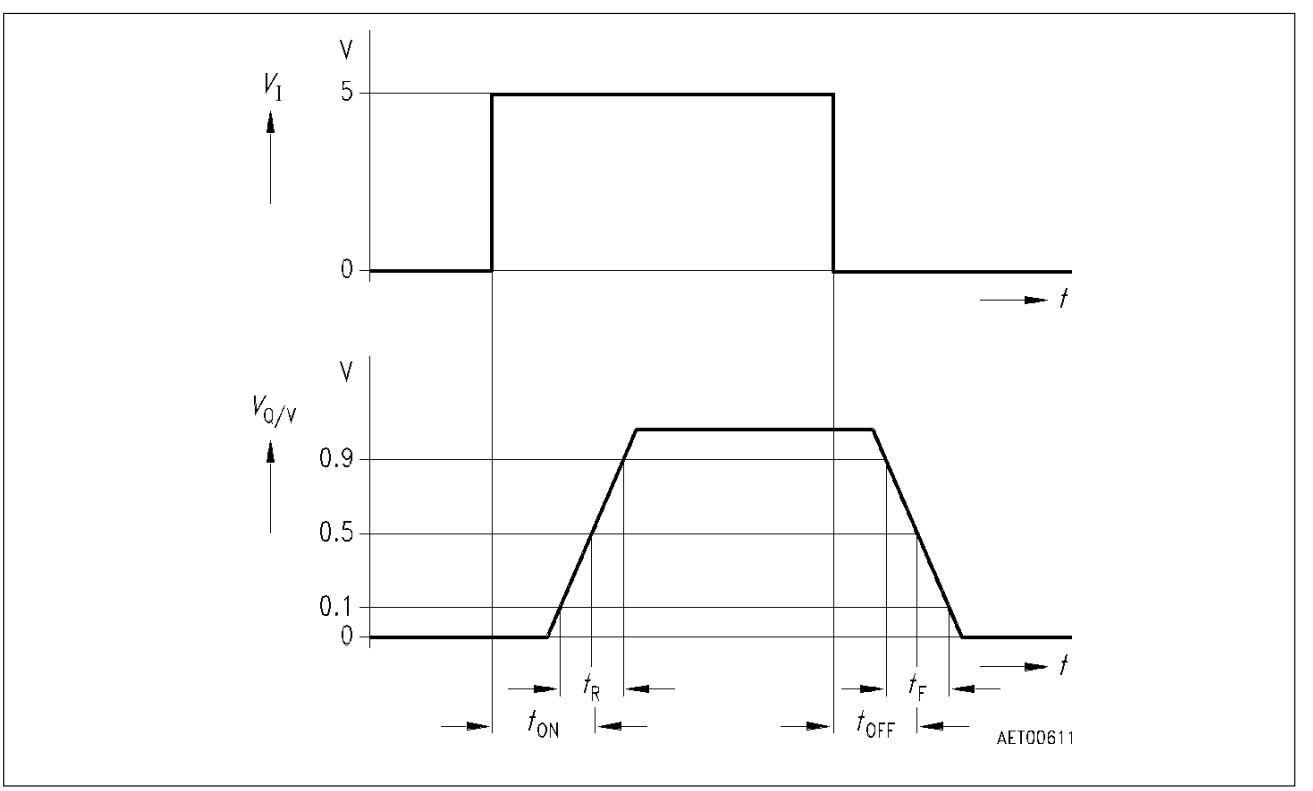
Test Circuit 2



Test Circuit 3

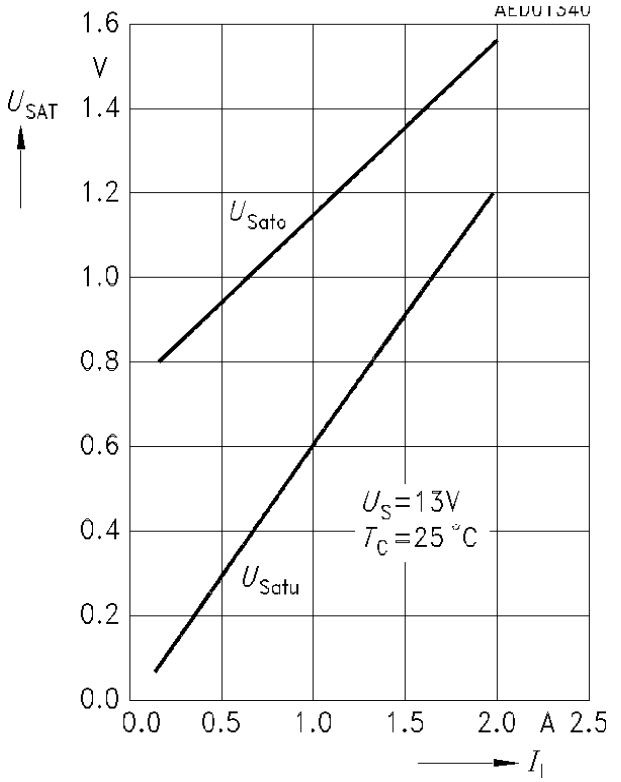


Application Circuit

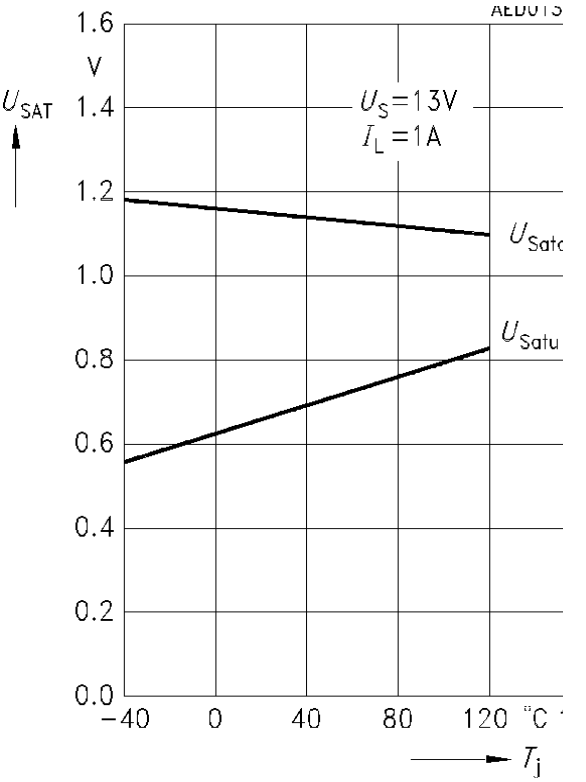


Diagrams

Saturation Voltage versus Output Current



Saturation Voltage versus Temperature



SIEMENS

4-A Motor Driver

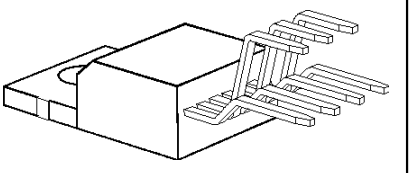
TLE 4203

Preliminary Data

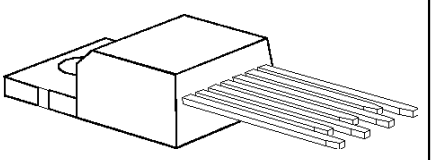
Bipolar IC

Features

- Integrated free-wheeling diodes
- Outputs short-circuit proof to V_S and ground
- Thermal overload protection
- Blocking of the output stages upon undervoltage
- Final push-pull stage free of cross-over



P-TO220-7-1



P-TO220-7-2

Type	Ordering Code	Package
TLE 4203	Q67000-A8121	P-TO220-7-1
▼ TLE 4203 S	Q67000-A9101	P-TO220-7-2

▼ New type

The integrated circuit TLE 4203 is a versatile double power driver of up to 4 A output current which is particularly suitable as a driver for DC motors in reversible operation.

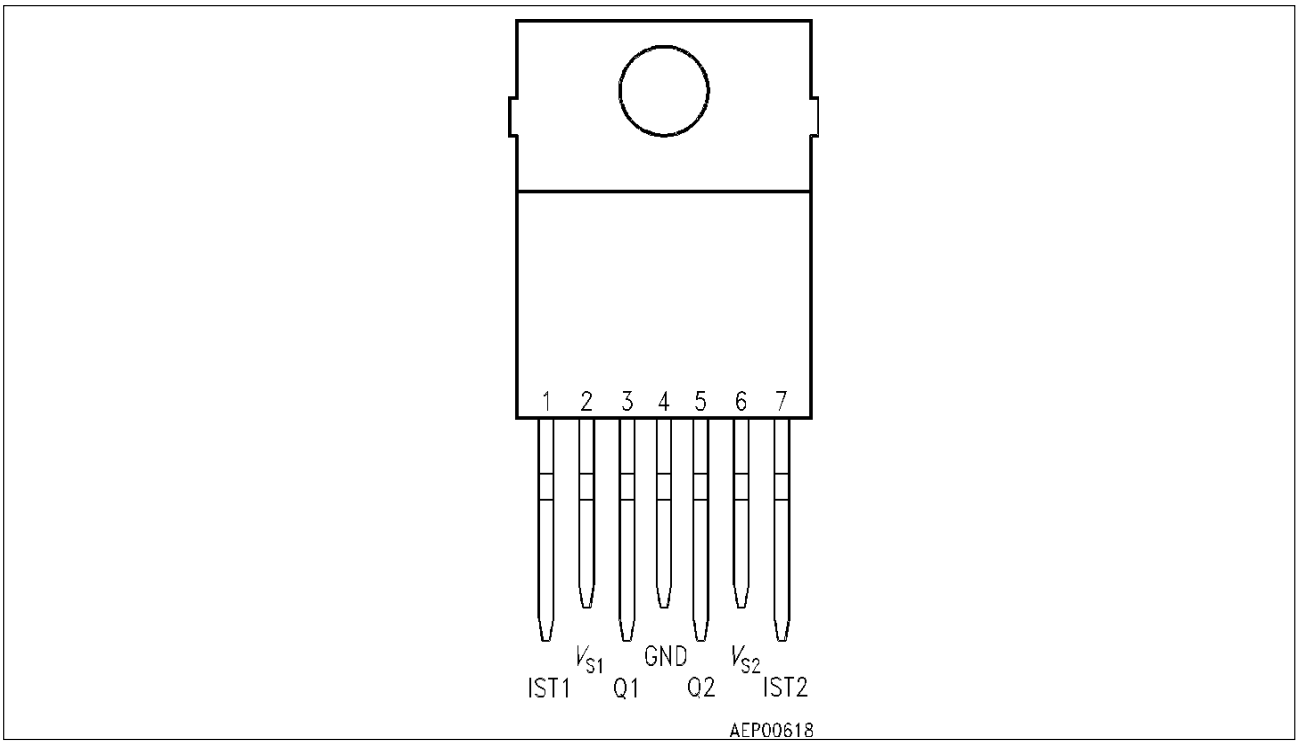
The push-pull power output stages operate in the switching mode and can be combined to a full-bridge configuration.

The drive of the input stage is implemented using digital logic.

The device contains a temperature protection logic, output stages protected against short-circuit and integrated free-wheeling diodes.

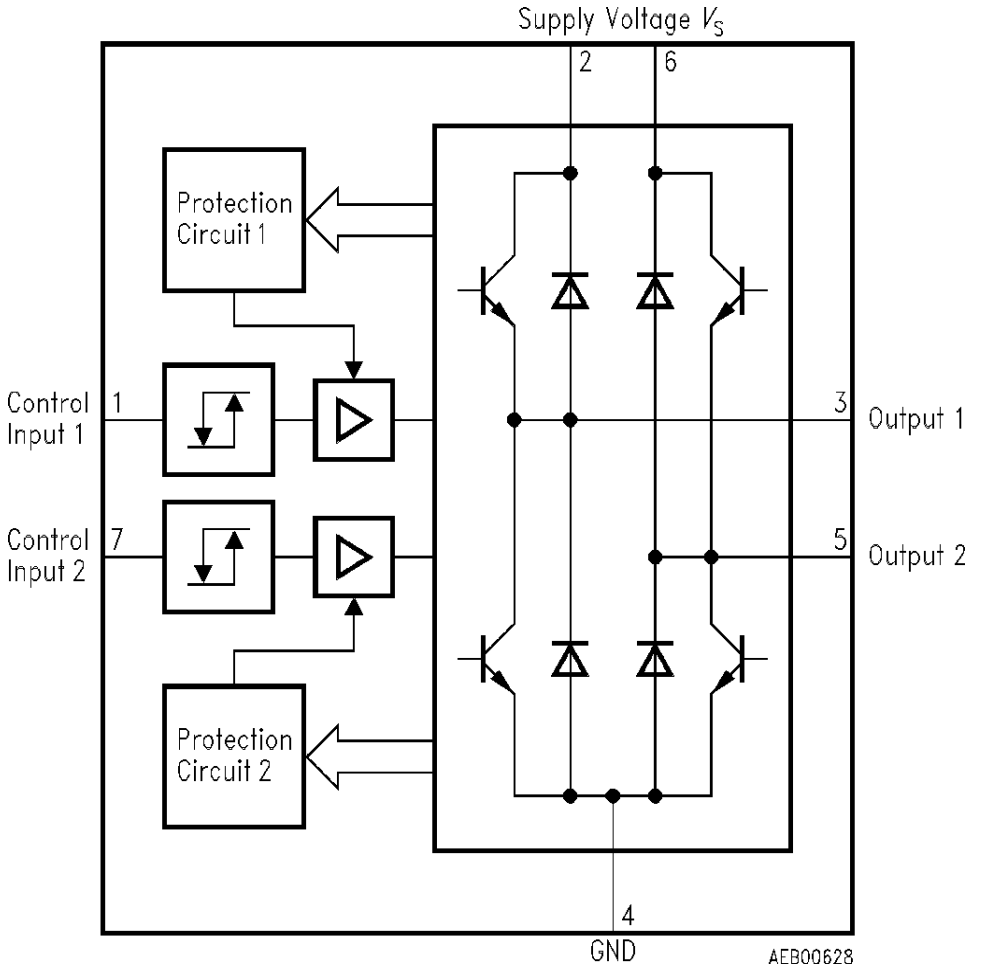
Typical applications are for follow-up control, servo drives, servo motors, drive mechanisms, etc.

Pin Configuration
(top view)



Pin Definitions and Functions

Pin No.	Symbol	Function
1	IST1	**Control input for channel 1** (TTL/CMOS-compatible), of non-inverting effect on the channel output.
2	V_{S1}	**Channel 1 supply voltage;** externally connected with the supply voltage pin for channel 2 (pin 6).
3	Q1	**Short-circuit protected push-pull C output** channel 1 for currents up to 6 A. Free-wheeling diodes are integrated on chip for inductive loads.
4	GND 1, 2	**Ground;** track should be designed for the max. short-circuit current (2 x 6 A).
5	Q2	**Short-circuit protected push-pull C output** channel 2 for currents up to 6 A. Free-wheeling diodes are integrated on chip for inductive loads.
6	V_{S2}	**Channel 2 supply voltage;** externally connected with the supply voltage pin for channel 1 (pin 2).
7	IST2	**Control input for channel 2** (TTL/CMOS-compatible), of non-inverting effect on the channel output.



Block Diagram

Application

In industrial and automotive electronics, power full-bridge DC motor drivers are mostly used for bidirectional motor drives. The two TTL and CMOS-compatible control inputs act on the output as follows:

Status	Input 1	Input 2	Output 1	Output 2
1	L	L	V_{QL}	V_{QL}
2	L	H	V_{QL}	V_{QH}
3	H	L	V_{QH}	V_{QL}
4	H	H	V_{QH}	V_{QH}

V_{QL} means:Lower power unit conducting; upper power unit blocked.
V_{QH} means:Upper power unit conducting; lower power unit blocked.

The following examples illustrate the operation:

Status 1: Motor is slowed down
Status 2: Motor turns right
Status 3: Motor turns left
Status 4: Motor is slowed down

Circuit Description

Input Circuit

The control inputs consist of TTL and CMOS-compatible Schmitt triggers with hysteresis. Buffer amplifiers, controlled from these stages, convert the logic signal into the form required for driving the power output stages.

Output Stages

The output stages consist of two push-pull C stages. Using protective circuits for limiting the power dissipation makes the outputs short-circuit proof to ground and to supply voltage throughout the entire operating range. Positive and negative voltage peaks, which occur when switching inductive loads, are limited by integrated power diodes.

Monitoring and Protecting Functions

The IC is protected against thermal overloads by a temperature protecting circuit.

In addition an internal circuit ensures that all output transistors are blocked for supply voltages below operating range.

A monitoring stage logic for each output stage transistor detects whether the relevant transistor is active and in this case for sink operation (source operation) prevents the corresponding source transistor (sink transistor) from being turned on. Direct cross-over currents are effectively prevented with this method.

Absolute Maximum Ratings

T_C = – 40 to 125 °C

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Voltages				
Supply voltage	V_S	– 0.3	45	V
Logic input voltages	$V_{I\,1,2}$	– 45	45	V
Currents				
Supply current $T_C \leq 85$ °C	I_S	– 12	12	A
Output current $T_C \leq 85$ °C	$I_{Q\,1,2}$	– 6	6	A
Ground current $T_C \leq 85$ °C	I_{GND}	– 12	12	A
Temperatures				
Junction temperature	T_j	–	150	°C
Storage temperature range	T_{stg}	– 50	150	°C
Thermal resistances				
system - case	$R_{th\,SC}$	–	3	K/W
system - ambient	$R_{th\,SA}$	–	65	K/W
Operating Range				
Supply voltage	V_S	5.0	20	V
Logic input voltage	$V_{I\,1,2}$	– 10	40	V
Case temperature $T_j \leq 150$ °C	T_C	– 40	125	°C

Characteristics

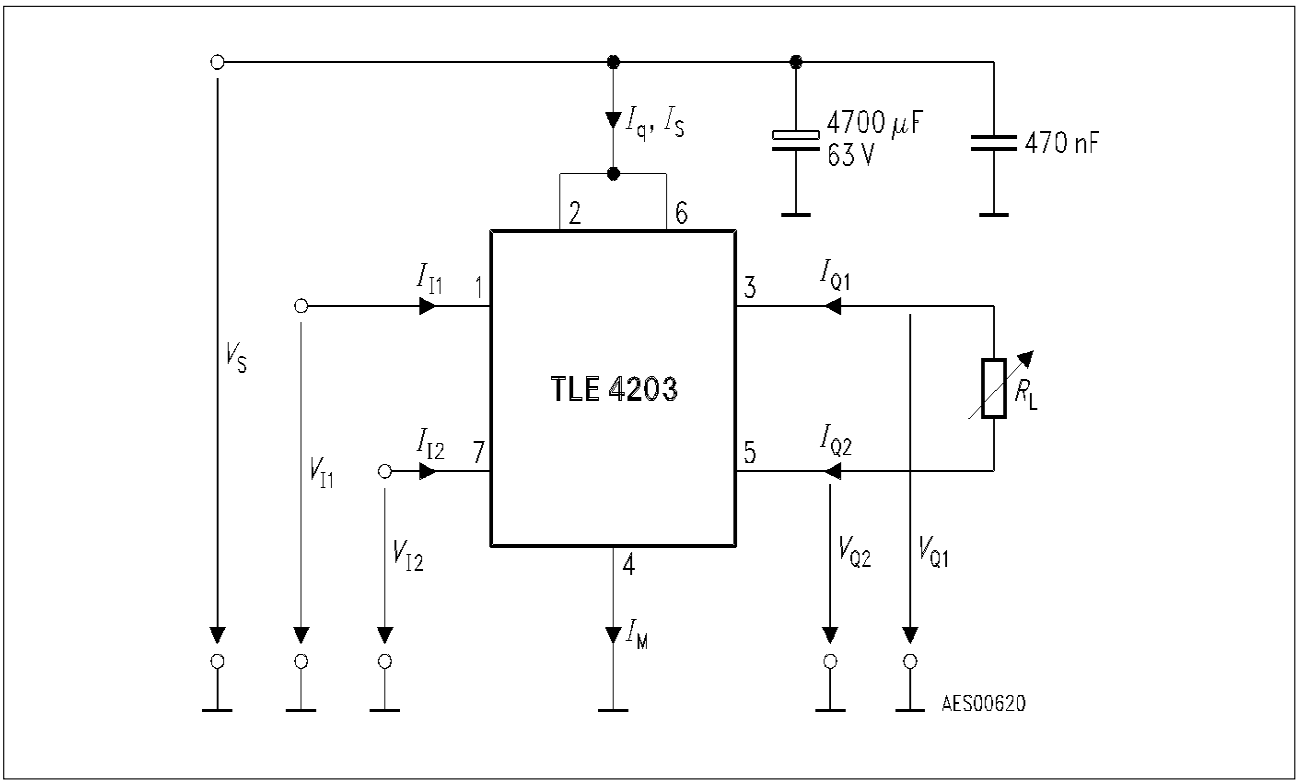
V_S = 8 to 18 V, T_j = – 25 to 125 °C (typ. V_S = 12 V; T_j = 25 °C)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
General Characteristics						
Quiescent current	I_q	–	70	100	mA	$V_{I1} = V_{I2} > V_{IH}$
Quiescent current	I_q	–	180	230	mA	$V_{I1} = V_{I2} < V_{IL}$
Logic						
Control inputs						
H-input voltage	V_{IH}	2.8	–	–	V	–
L-input voltage	V_{IL}	–	–	1.2	V	–
Hysteresis of input voltage	ΔV_I	–	0.7	–	V	–
H-input current	I_{IH}	–	–	10	µA	V_I = 5 V
L-input current	$-I_{IL}$	–	–	10	µA	V_I = 0.5 V

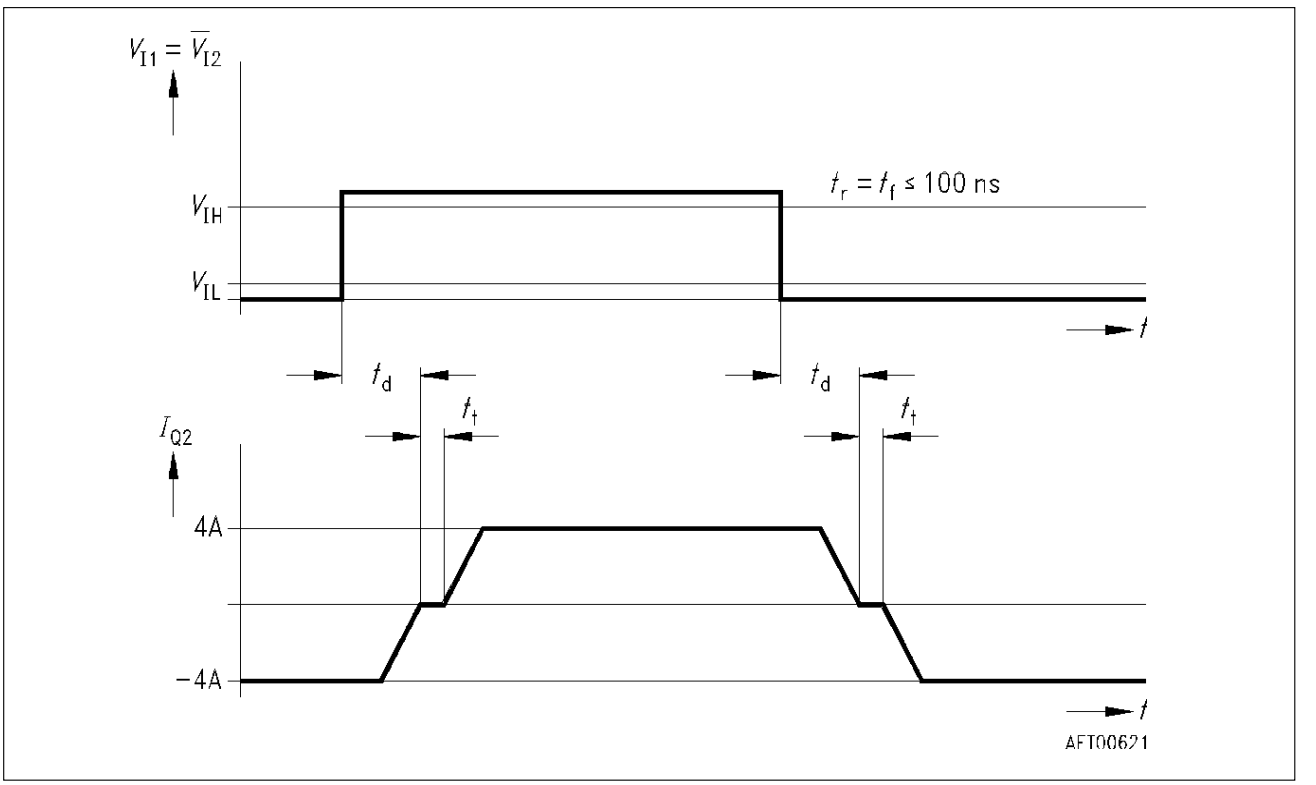
V_S = 8 to 18 V, T_C = – 25 to 125 °C

Switching Stages						
Saturation voltages						
to + V_S	V_{QSato}	–	1.1	1.3	V	$V_{I\,1,\,2} > V_{IH}$; $I_Q = -1$ A [1]
to + V_S	V_{QSato}	–	1.5	1.8	V	$V_{I\,1,\,2} > V_{IH}$; $I_Q = -2$ A [1]
to + V_S	V_{QSato}	–	2.5	3.5	V	$V_{I\,1,\,2} > V_{IH}$; $I_Q = -4$ A [1]
to ground	V_{QSatu}	–	0.3	0.6	V	$V_{I\,1,\,2} < V_{IL}$; $I_Q = 1$ A
to ground	V_{QSatu}	–	0.6	1.0	V	$V_{I\,1,\,2} < V_{IL}$; $I_Q = 2$ A
to ground	V_{QSatu}	–	1.6	3.2	V	$V_{I\,1,\,2} < V_{IL}$; $I_Q = 4$ A
Forward Voltages						
Diode to + V_S	$-V_{QFo}$	–	0.95	1.3	V	$V_{I\,1/\,2} > V_{IH}$; $I_Q = 1$ A [1]
Diode to + V_S	$-V_{QFo}$	–	1.05	1.5	V	$V_{I\,1/\,2} > V_{IH}$; $I_Q = 2$ A [1]
Diode of + V_S	$-V_{QFo}$	–	1.30	1.8	V	$V_{I\,1/\,2} > V_{IH}$; $I_Q = 4$ A [1]
Diode to ground	$-V_{QFu}$	–	0.95	1.3	V	$V_{I\,1/\,2} < V_{IL}$; $I_Q = -1$ A
Diode to ground	$-V_{QFu}$	–	1.00	1.5	V	$V_{I\,1/\,2} < V_{IL}$; $I_Q = -2$ A
Diode to ground	$-V_{QFu}$	–	1.20	1.8	V	$V_{I\,1/\,2} < V_{IL}$; $I_Q = -4$ A

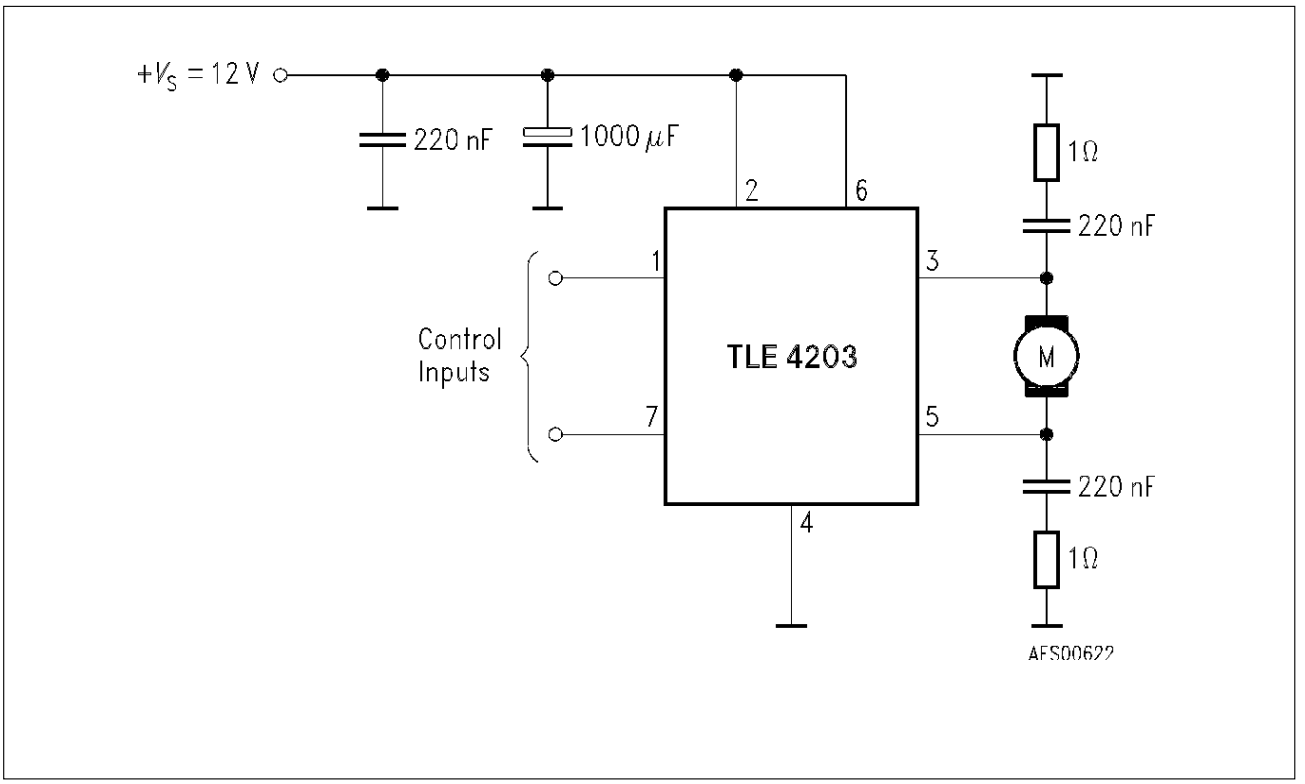
[1] measured to + V_S



Test Circuit

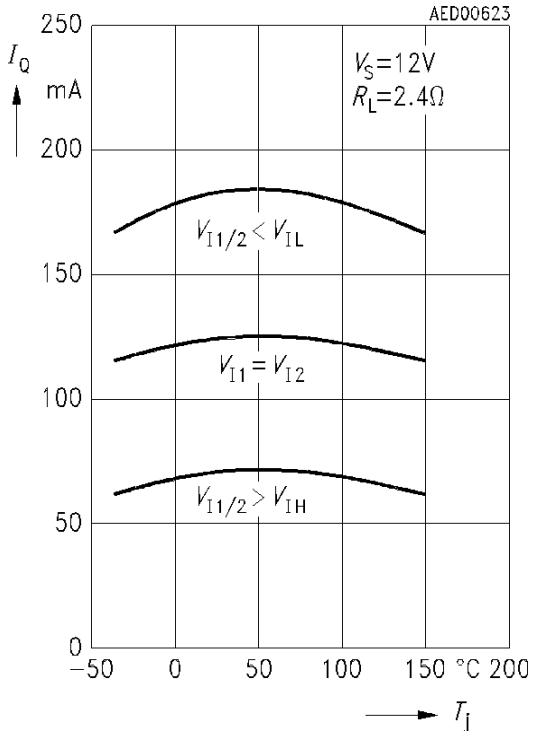


Timing Diagram



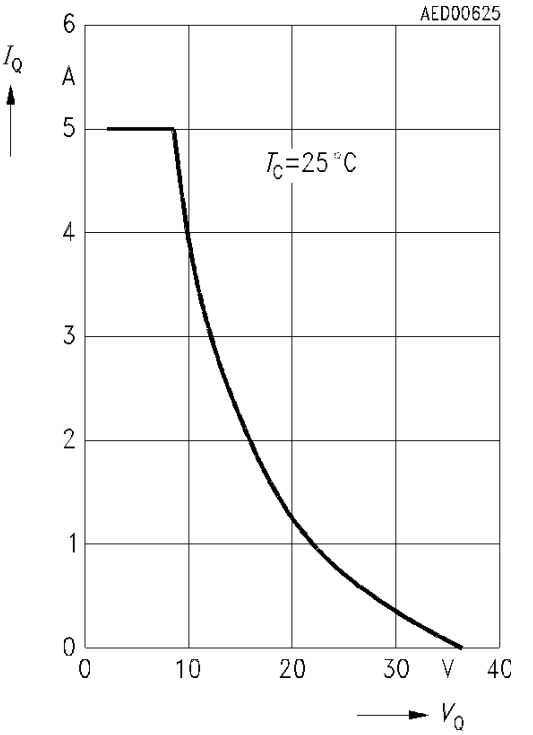
Application Circuit

Saturation Voltage versus Output Current

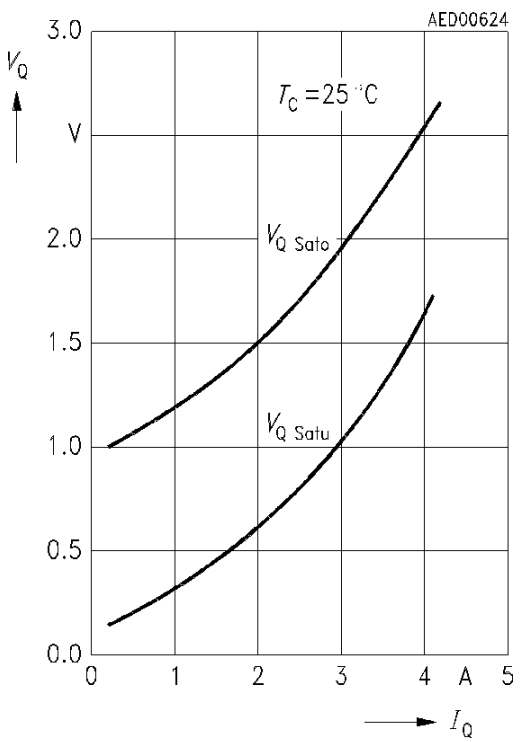


Short-Circuit Current versus Output Voltage

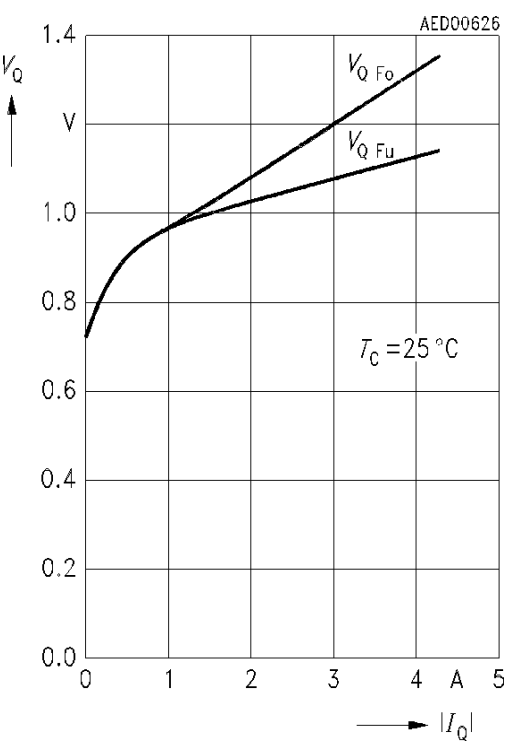
$V_A = V_Q$ for sink operation
$V_A = V_S - V_Q$ for source operation



Saturation Voltage versus Output Current



Diode Forward Voltage versus Output Current



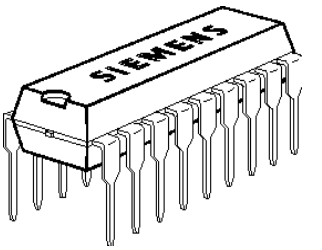
SIEMENS

Motor Driver **TLE 4205**

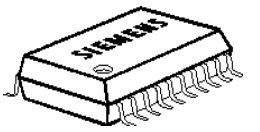
Bipolar IC

Features

- Max. driver current 1 A
- Integrated free-wheeling diodes
- Short-circuit proof to ground
- Inhibit
- ESD protected inputs
- Temperature range – 40 °C ≤ T_j ≤ 150 °C



P-DIP-18-1



P-DSO-20-6

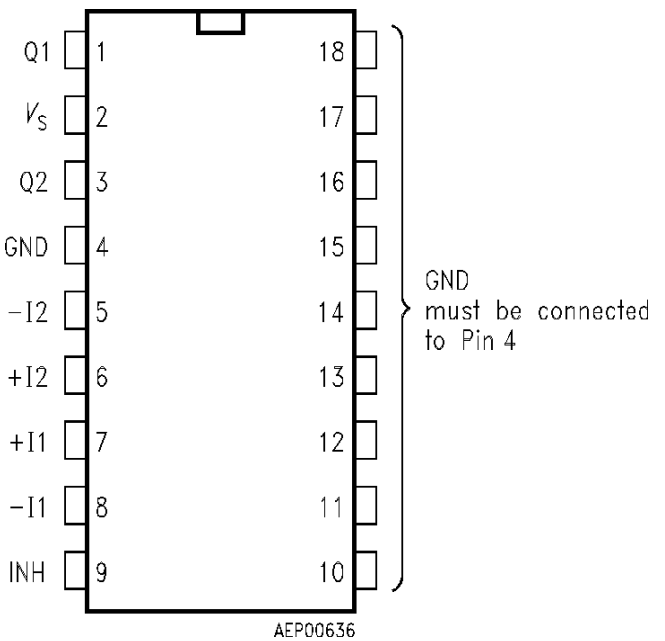
Type	Ordering Code	Package
TLE 4205	Q67000-A9025	P-DIP-18-1
▼ TLE 4205 G	Q67000-A9114	P-DSO-20-6 (SMD)

▼ New type

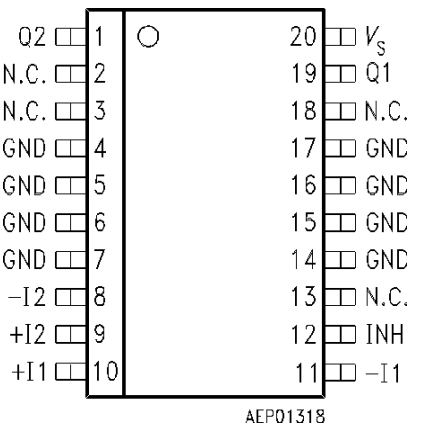
TLE 4205 is an integrated power full-bridge DC-motor driver for a wide temperature range, as required in automotive applications for example. The circuit contains two power comparators that can be combined to a full-bridge circuit. For inductive loads there are integrated free-wheeling diodes to + V_S and ground. The outputs are short-circuit proof from 18 V to ground and turn-OFF when overtemperature occurs. This IC is especially suitable for headlight-beam adjustment in automobiles.

Pin Configuration
(top view)

TLE 4205



TLE 4205 G

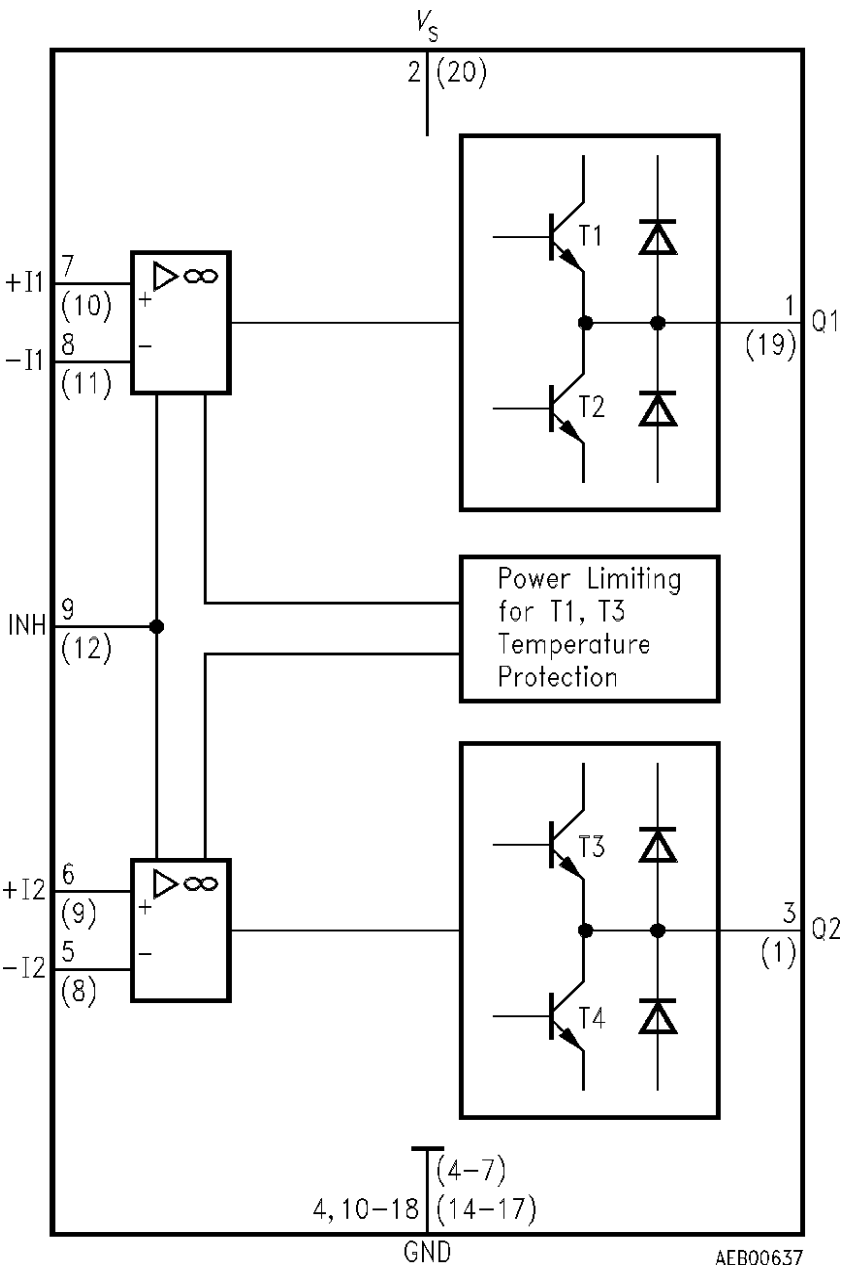


Pin Definitions and Functions (TLE 4205)

Pin	Symbol	Function
1	Q1	**Output Q1 of channel 1;** push-pull B output with DC short-circuit protection to ground. Integrated free-wheeling diodes to ground and the supply voltage.
2	V_S	**Supply voltage V_S;** must be blocked to ground with a ceramic capacitor of at least 100 nF directly on the pins of the IC.
3	Q2	**Output Q2 of channel 2;** see pin 1.
4	GND	**Ground**
5	– I2	**Inverting input channel 2;** to be wired according to general rules.
6	+ I2	**Non-inverting input channel 2;** to be wired according to general rules.
7	+ I1	**Non-inverting input channel 1;** see pin 6.
8	– I1	**Inverting input channel 1;** see pin 5.
9	INH	**Inhibit;** the IC is passive when this pin is open or connected to ground.
10-18	GND	**Ground;** must be connected to pin 4.

Pin Definitions and Functions (TLE 4205 G)

Pin	Symbol	Function
1	Q2	**Output 2 of channel 2;** push-pull B output with DC short-circuit protection to ground. Integrated free-wheeling diodes to ground and the supply voltage.
2	N.C.	Not connected
3	N.C.	Not connected
4-7	GND	**Ground**
8	– I2	**Inverting input channel 2;** to be wired according to general rules.
9	+ I2	**Non-inverting input channel 2;** to be wired according to general rules.
10	+ I1	**Non-inverting input channel 1;** see pin 6.
11	– I1	**Inverting input channel 1;** see pin 5.
12	INH	**Inhibit;** the IC is passive when this pin is open or connected to ground.
13	N.C.	Not connected
14-17	GND	**Ground**
18	N.C.	Not connected
19	Q1	**Output Q1;** must be connected to pin 4.
20	V_S	**Supply voltage;** must be connected to pin 4.

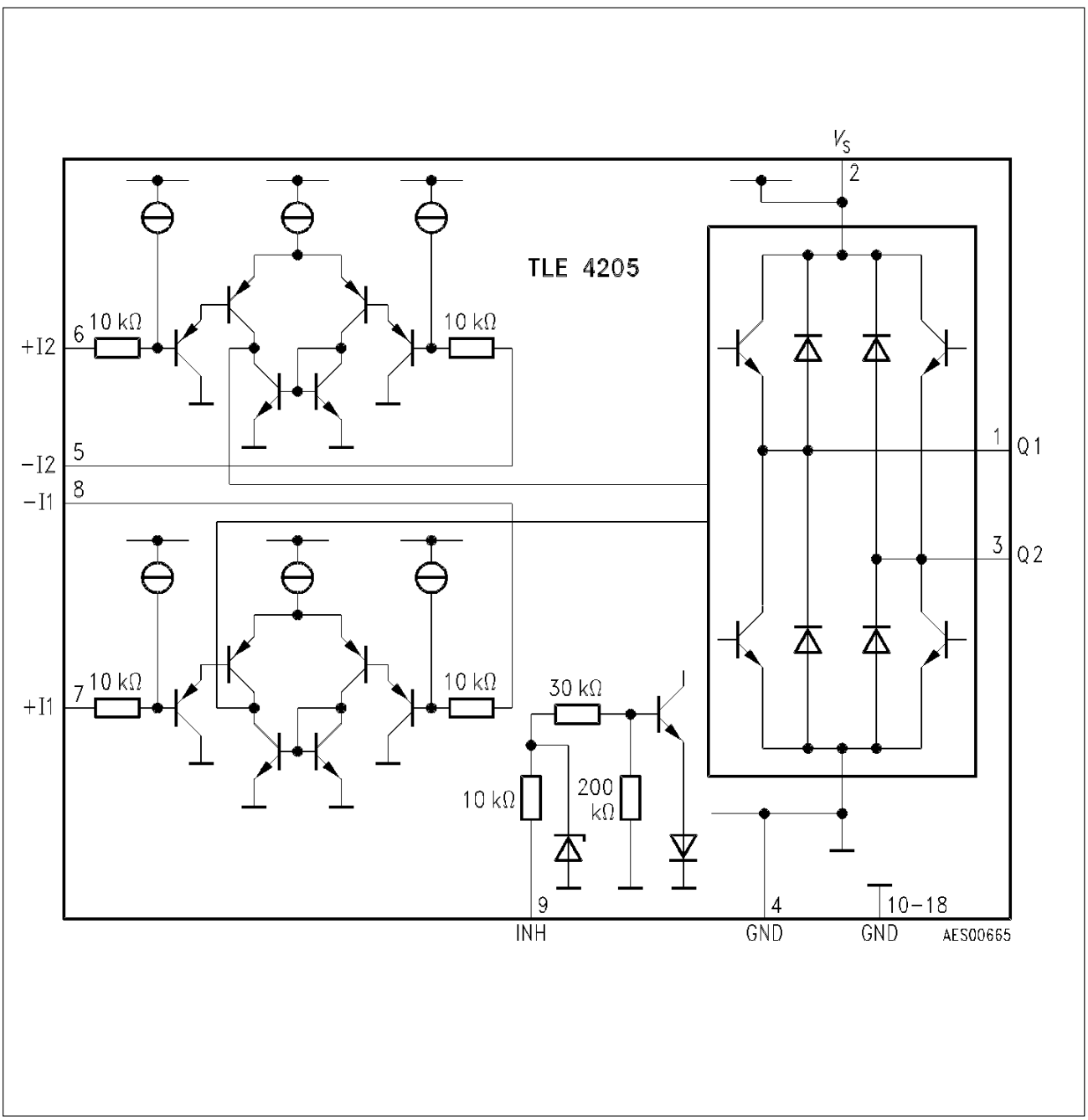


Block Diagram

Circuit Description

The IC contains two amplifiers with typical open-loop gain of 80 dB at 500 Hz.

The input stages consist of PNP-differential amplifiers. This produces a common-mode input range of 0 V to nearly V_S and a maximum differential input voltage of V_S. The IC is guarded against ground shorts by an SOA-protective circuit. The output transistors are turned off if the chip temperature exceeds approx. 160 °C. The IC can be turned off by an inhibit input, which very much reduces current consumption.



Circuit Diagram

Absolute Maximum Ratings

T_j = – 40 to 150 °C

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	V_S	– 0.3	45	V	
Differential input voltage	V_{ID}		$\pm V_S$	V	$\Delta V_{6\text{-}5}$ or $\Delta V_{7\text{-}8}$ TLE 4205 $\Delta V_{8\text{-}9}$ or $\Delta V_{10\text{-}11}$ TLE 4205 G
Output current	I_Q	– 1	1	A	
Supply current	I_S	2.5	3	A	
Ground current	I_{GND}	– 3	2.5	A	I2
Input voltage	V_I	– 15	+ V_S	V	V_5; V_6; V_7; V_8 TLE 4205 V_8; V_9; V_{10}; V_{11} TLE 4205 G
Inhibit input	V_9	– 15	+ V_S	V	
Junction temperature	T_j		150	°C	
Storage temperature	T_{stg}	– 50	150	°C	

Operating Range

Supply voltage	V_S	6	32	V	
Case temperature	T_C	– 40	105	°C	P_{Dmax} = 3 W
Thermal resistance junction - ambient junction - case	 $R_{th\ JA}$ $R_{th\ JC}$		 60 15	 K/W K/W	 TLE 4205 TLE 4205
Thermal resistance junction - ambient junction - case	 $R_{th\ JA}$ $R_{th\ JC}$		 65 3	 K/W K/W	 TLE 4205 G TLE 4205 G

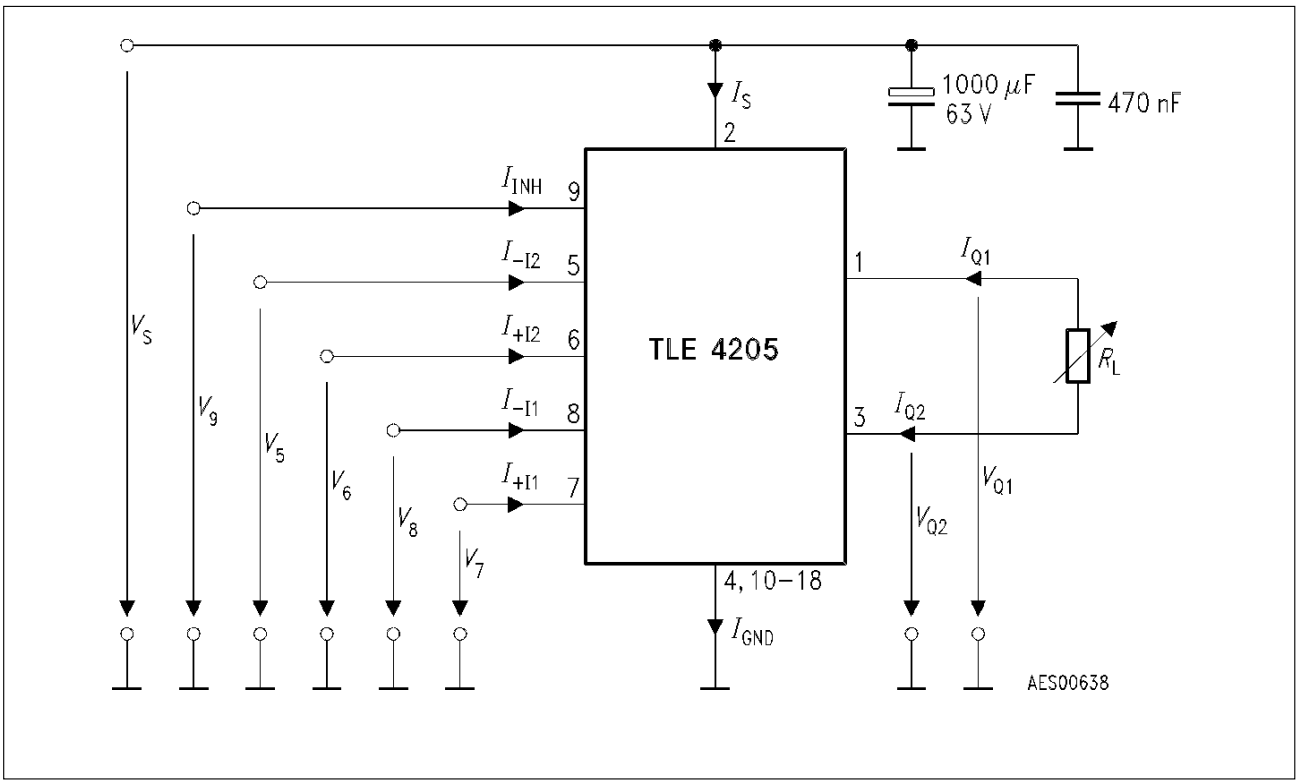
Outputs pin 1 and pin 3 short-circuit proof to GND at $V_S \leq 18$ V

Characteristics
V_S = 13.5 V; T_j = 25 °C

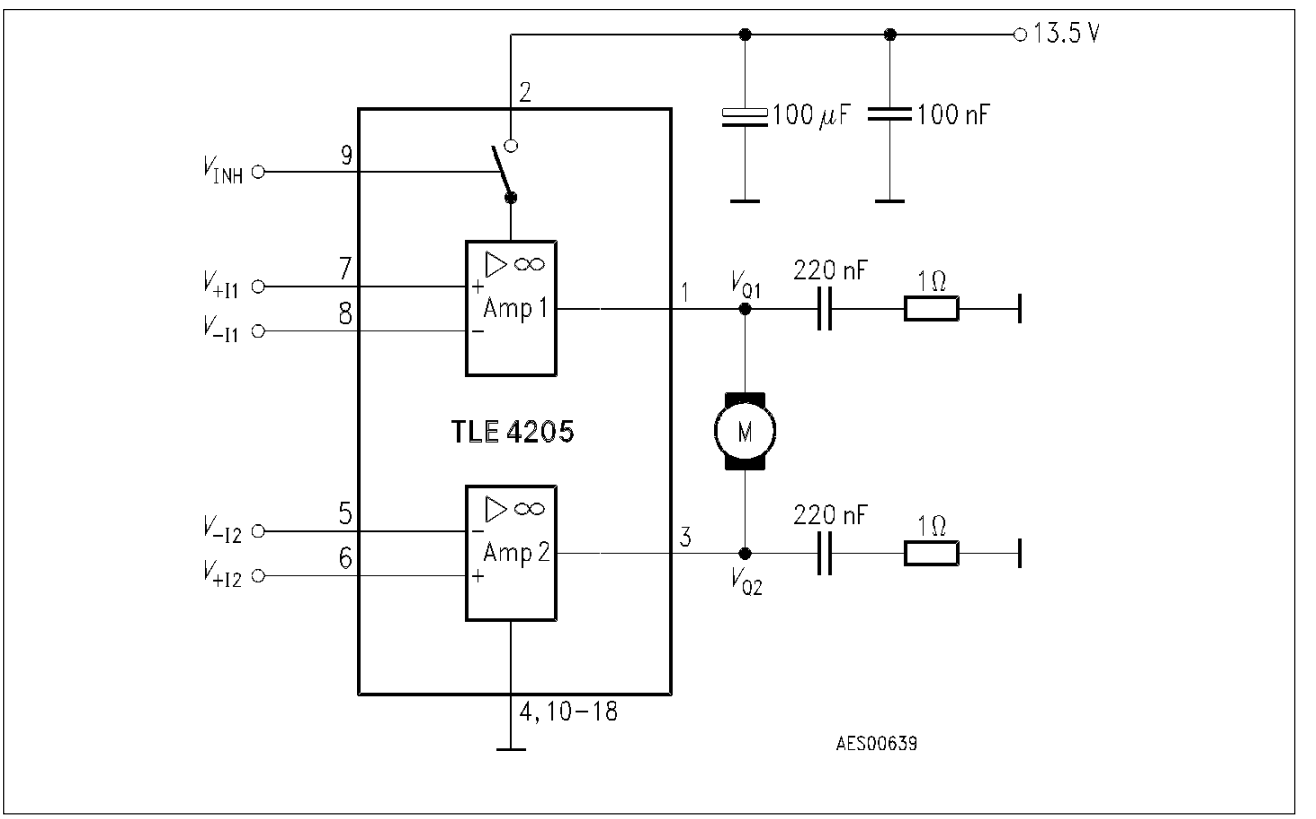
Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
General						
Open-circuit current consumption	I_S		10	30	mA	active
Open-circuit current consumption	I_S		10	100	µA	inhibit
Turn-ON dead time ref. to $V_{9\ OFF/ON}$	$t_{d\ ON}$		10	20	µs	$\|I_{1,3}\|$ < 1 A TLE 4205 $\|I_{1,19}\|$ < 1 A TLE 4205 G
Turn-OFF dead time ref. to $V_{9\ OFF/ON}$	$t_{d\ OFF}$		10	20	µs	$\|I_{1,3}\|$ < 1 A TLE 4205 $\|I_{1,19}\|$ < 1 A TLE 4205 G
Open-loop gain	G_{VO}	50	80		dB	f = 500 Hz
Inputs						
Input zero voltage	V_{IO}	– 7.5		7.5	mV	R_S = 10 kΩ; – 40 °C ≤ T_j ≤ 85 °C
Input-voltage drift	$\Delta V_{IO}/\Delta T$		20	30	µV/K	– 40 °C ≤ T_j ≤ 85 °C
Input zero current	I_{IO}	– 75		75	mA	– 40 °C ≤ T_j ≤ 85 °C
Input current	I_I	– 300		300	nA	– 40 °C ≤ T_j ≤ 85 °C
Input-current drift	$\Delta I_I/\Delta T$			5	nA/K	– 40 °C ≤ T_j ≤ 85 °C
Input common-mode range, positive	V_{IC}			V_S – 2	V	
Input common-mode range, negative	V_{IC}			– 0.5	V	

Characteristics (cont'd)
V_S = 13.5 V; T_j = 25 °C

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Power-supply rejection ratio	$PSSR$			200	µV/V	R_S = 10 kΩ; – 40 °C ≤ T_j ≤ 85 °C
Common-mode rejection ratio	$CMRR$	70	80		dB	
Outputs						
Saturation voltage	V_{Satu}		1.0	1.5	V	I_Q = 0.6 A; – 40 °C ≤ T_j ≤ 85 °C
Saturation voltage	V_{Sat1}		1.0	1.5	V	I_Q = 0.6 A; – 40 °C ≤ T_j ≤ 85 °C
Forward voltage of free-wheeling diode	V_{Fu}		1.0	1.5	V	I_Q = 0.6 A; – 40 °C ≤ T_j ≤ 85 °C
Forward voltage of free-wheeling diode	V_{F1}		1.0	1.5	V	I_Q = 0.6 A; – 40 °C ≤ T_j ≤ 85 °C
Slew rate of V_Q	$dV_q dt_r$		0.5		V/µs	
Inhibit Input						
Switching threshold high	V_{IH}	2			V	
Switching threshold low	V_{IL}			0.8	V	
H-input current	I_{IH}		100		µA	V_9 = 5 V
L-input current	I_{IH}		0		µA	V_9 = 0 V

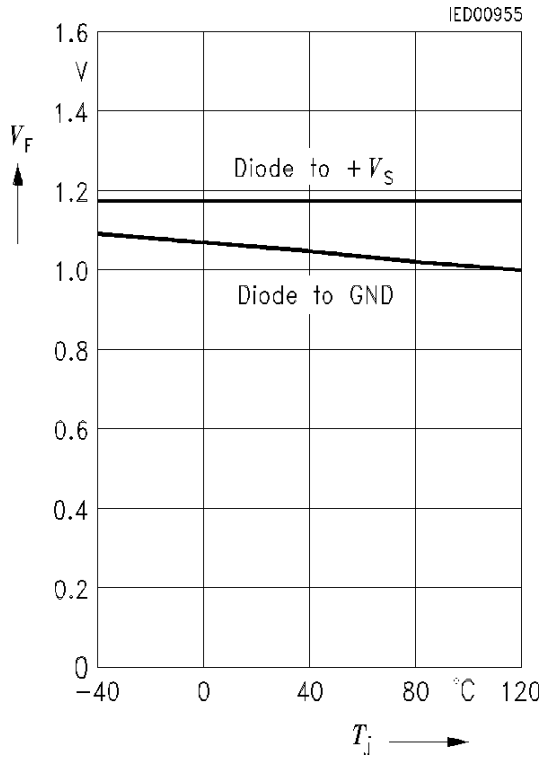


Test Circuit

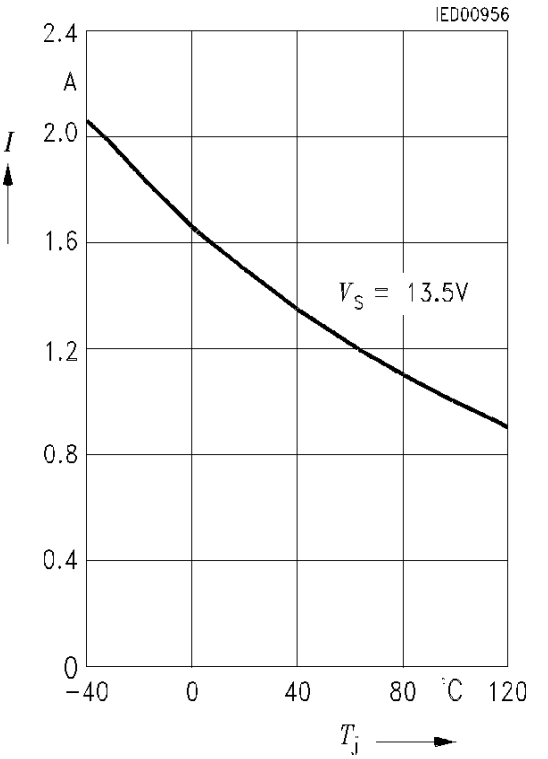


Application Circuit

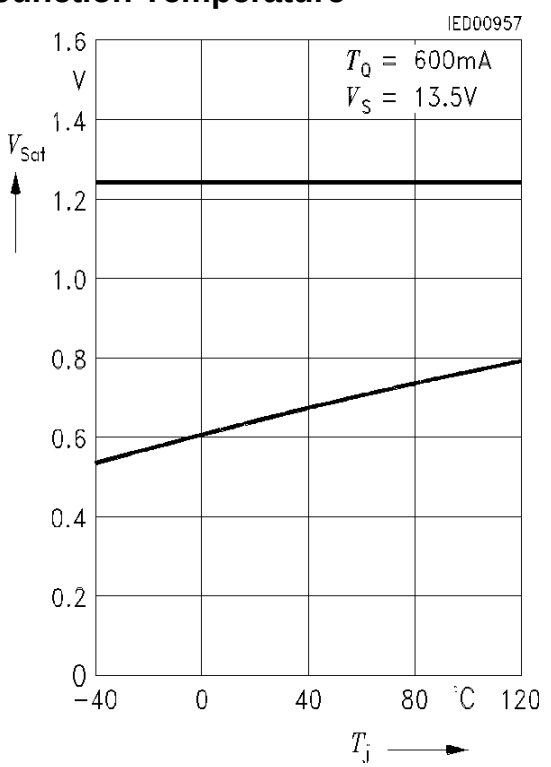
Forward Voltage of the Free-Wheeling Diodes versus Junction Temperature



Start Point of the SOA-Protection Circuit versus Junction Temperature



Saturation Voltage versus Junction Temperature



Current Consumption versus Junction Temperature