

3-A Motor Driver

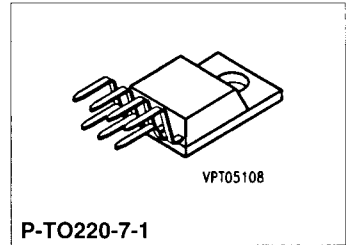
TLE 4204

Preliminary Data

Bipolar IC

Features

- Max. output current 4 A
- Outputs short-circuit proof to $\pm V_s$
- Thermal overload protection
- Integrated free-wheeling diodes to $\pm V_s$
- Max. supply voltage 45 V
- Suitable for automotive applications



Type	Ordering Code	Package
■ S TLE 4204	Q67000-A8182	P-TO220-7-1

■ Not for new design

Integrated 3 A full-bridge DC motor driver with temperature protection, fully protected output stages and integrated free-wheeling diodes. The case temperature range is -40°C to 125°C . The IC is also especially suitable for application in automotive electronics.

Application Description

In industrial and automotive electronics full-bridge DC motor drivers are mostly applied in bidirectional motor drives. Both of the differential control inputs act on the outputs as follows:

State	Differential input voltage 1	Differential input voltage 2	Output 1	Output 2
1	< 0	< 0	V_{QL}	V_{QL}
2	< 0	> 0	V_{QL}	V_{QH}
3	> 0	< 0	V_{QH}	V_{QL}
4	> 0	> 0	V_{QH}	V_{QH}

V_{QL} means: Lower power unit conducts; upper power unit is blocked

V_{QH} means: Upper power unit conducts; lower power unit is blocked

Examples:

State 1: Motor is slowed down

State 2: Motor turns right

State 3: Motor turns left

State 4: Motor is slowed down

Circuit Description

Input Circuit

The input stages are designed as differential inputs with an open-loop gain of typ. 80 dB and a common-mode input voltage range to 0V.

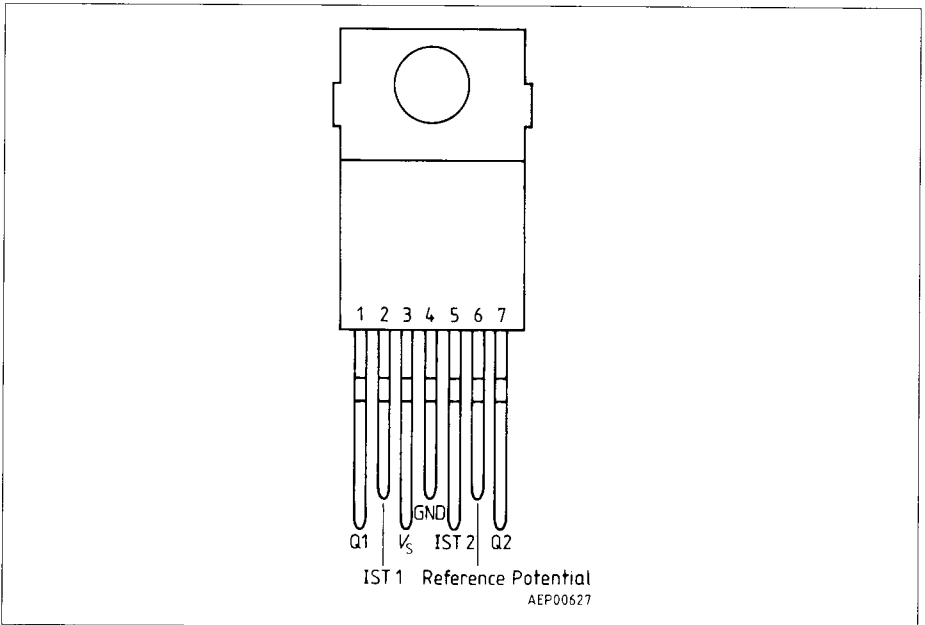
Output Stages

The output stages consist of two push-pull C stages. Using the 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 during switching of inductive loads, are limited by integrated diodes.

Monitoring and Protecting Functions

The IC is protected against thermal overload by a temperature protecting unit.

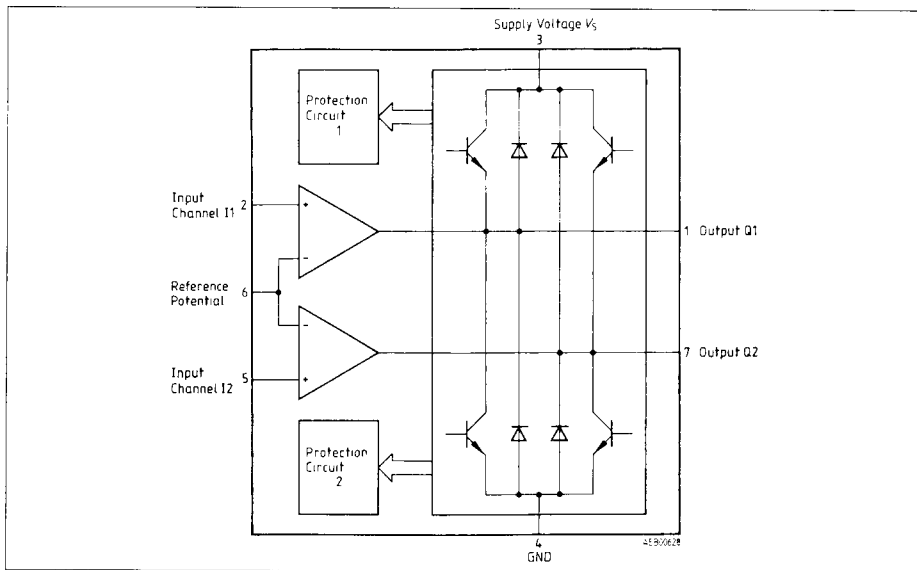
The power units are controlled by a protection circuit. At low voltages (up to 8 V) only the current is limited in order to protect the bond leads. At higher voltages the protection circuit controls the power dissipation in the power unit.



Pin Configuration (top view)

Pin Definitions and Functions

Pin	Symbol	Function
1	Q1	Output of channel 1 Short-circuit proof push-pull C output channel 1 for rated currents up to 3 A. Free-wheeling diodes to + V_s and to ground are integrated.
2	IST1	Control input for channel 1 Differential input referred to pin 6; of non-inverting effect on output channel 1. The common-mode range is specified from $V_s - 2.5 V$ to ground.
3	V_s	Supply voltage Block against ground (pin 4) with a ceramic capacitor of 220 nF min. close to pin 3. For longer connections a low-inductance circuit-proof supporting electrolytic capacitor of at least 10 μF between pin 3 and 4 is to be supplied. The connection is to be designed for the maximum short-circuit current ($2 \times 4 A$).
4	GND	Ground Design the connection for the maximum short-circuit current ($2 \times 4 A$).
5	IST2	Control input channel 2 Differential input referred to pin 6; of non-inverting effect on output 2. The common-mode range is specified from $V_s - 2.5 V$ to ground.
6	Reference potential	Input reference potential for channel 1 and 2 The user can individually determine the switching threshold with this input. The common-mode range is specified from $V_s - 2.5 V$ to ground.
7	Q2	Output of channel 2 Short-circuit proof push-pull C output channel 2 for rated currents up to 3 A. Free-wheeling diodes to + V_s and to ground are integrated.



Block Diagram

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
Input voltages Pin 2, 5 and 6	V_i	-0.3	+ V_S	V

Currents

Supply current $T_c \leq 85$ °C	I_S	-3	8	A
Output current $T_c \leq 85$ °C	$I_{O1,2}$	-4	4	A
Ground current $T_c \leq 85$ °C	I_{GND}	-8	8	A
Diode peak currents to + V_S	I_{F+}	-	1.5	A
to ground	I_{F-}	-	4	A

Absolute Maximum Ratings (cont'd)

$T_C = -40$ to 125 °C

Parameter	Symbol	Limit Values		Unit
		min.	max.	

Temperatures

Junction temperature	T_j	–	150	°C
Storage temperature range	T_{stg}	– 50	150	°C

Operating Range

Supply voltage	V_S	8	24	V
Case temperature	T_C	– 40	125	°C
$T_j \leq 150$ °C				
Thermal resistance system - case	$R_{th SC}$	–	4	K/W
system - ambient	$R_{th SA}$	–	65	K/W

Characteristics

$V_S = 12$ V; $T_C = 25$ °C

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

General Ratings

Quiescent current	I_i	–	15	30	mA	$V_{2.5} = 12$ V; $V_6 = 0$ V
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Control Inputs

Input offset voltage	V_{i0}	– 10	–	10	mV	–
Input offset current	I_{i0}	– 100	–	100	nA	–
Input current	$-I_{i2.5}$	–	1	2	µA	$V_{2.5} = 0$ V $V_6 = 12$ V
Input current	$-I_{i6}$	–	2	4	µA	$V_{2.5} = 12$ V $V_6 = 0$ V
Common-mode input voltage ranges to + V_S	V_{C+}	–	2.5	3	V	Difference to + V_S to ground
to ground	V_{C-}	–	– 0.5	0	V	

Characteristics (cont'd)

$V_S = 12\text{ V}$; $T_C = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

Output Stages

Saturation voltages						
to + V_S	V_{QSato}	–	1.0	1.3	V	$V_{I6} < V_{I2.5}$; $I_O = -1\text{ A}^{1)}$
to + V_S	V_{QSato}	–	2.0	2.5	V	$V_{I6} < V_{I2.5}$; $I_O = -3\text{ A}^{1)}$
to ground	V_{QSatu}	–	1.0	1.3	V	$V_{I6} < V_{I2.5}$; $I_O = 1\text{ A}$
to ground	V_{QSatu}	–	2.0	2.5	V	$V_{I6} < V_{I2.5}$; $I_O = 3\text{ A}$
Forward voltages						
to + V_S	V_{Fo}	–	1.2	1.4	V	$V_{I6} < V_{I2.5}$; $I_O = 1\text{ A}^{1)}$
to ground	V_{Fu}	–	-1	-1.2	V	$V_{I6} > V_{I2.5}$; $I_O = -1\text{ A}$
to ground	V_{Fu}	–	-1.4	-1.6	V	$V_{I6} > V_{I2.5}$; $I_O = -3\text{ A}$
Short-circuit currents						S 1P, 2P closed
at short-circuit to + V_S						$V_{I6} > V_{I2.5}$
	$I_{QP1,7}$	–	2.5	3.5	A	$V_S = 12\text{ V}$
	$I_{QP1,7}$	–	1.0	–	–	$V_S = 24\text{ V}$
at short-circuit to ground						S 1M, 2M closed
						$V_{I6} > V_{I2.5}$
	$-I_{QM1,7}$	–	2.5	–	A	$V_S = 12\text{ V}$
	$-I_{QM1,7}$	–	1.5	3.5	A	$V_S = 24\text{ V}$

Switching Times

Turn-ON time	$t_{D ON}$	–	2	4	μS	see figure 2
Turn-OFF time	$t_{D OFF}$	–	3	6	μS	see figure 2

¹⁾ measured to + V_S

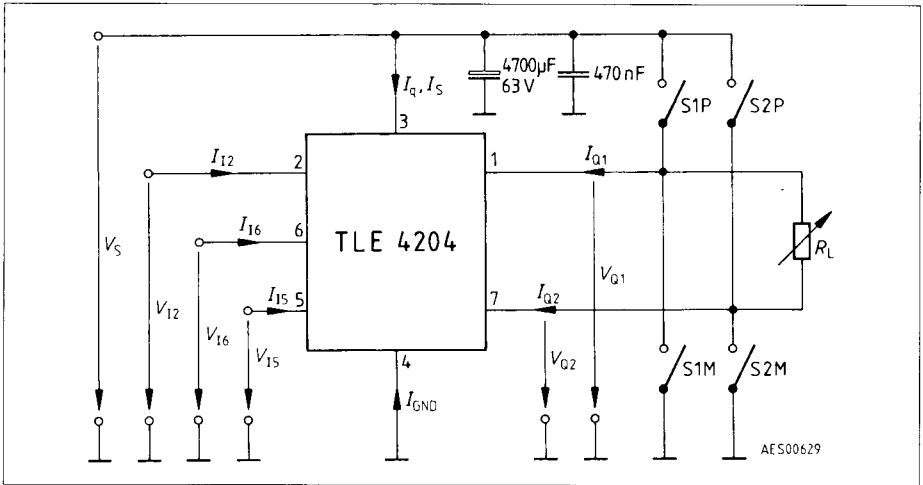


Figure 1
Test Circuit

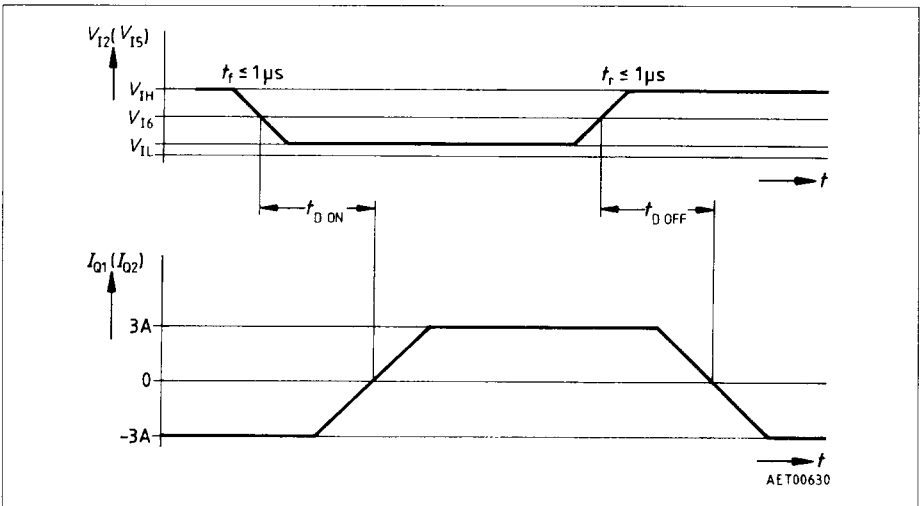


Figure 2
Timing Diagram

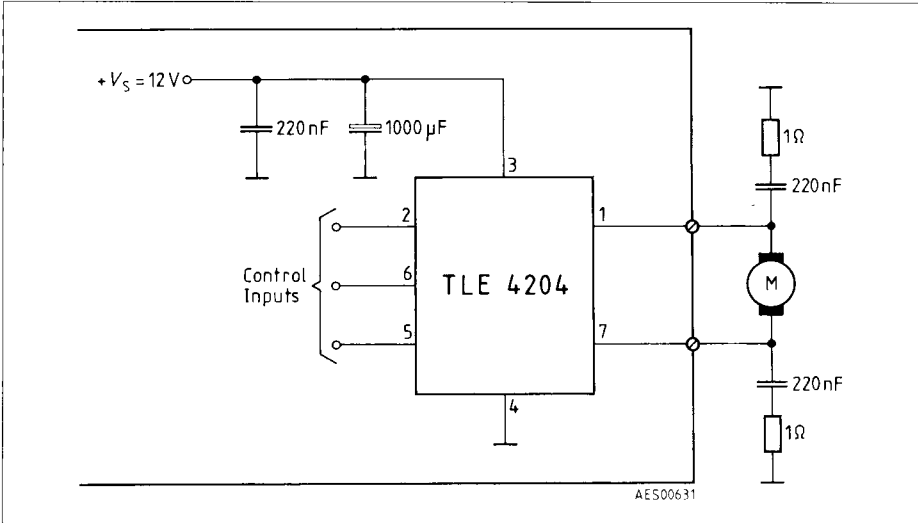
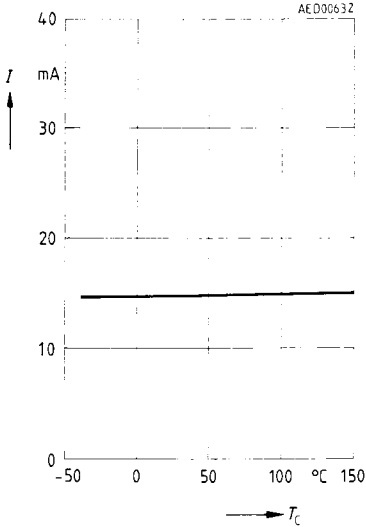


Figure 3
Application Circuit

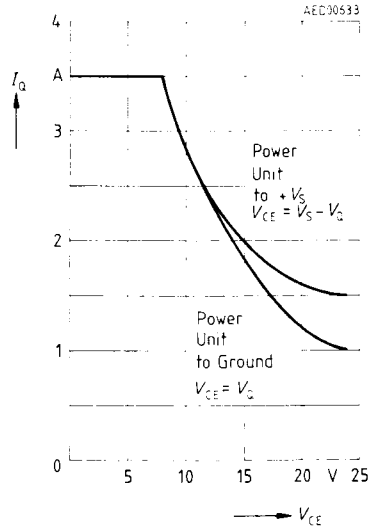
Quiescent Current versus Case Temperature T_C

$V_S = 12\text{ V}; V_{I2/5} = V_S; V_{I6} = 0\text{ V}$



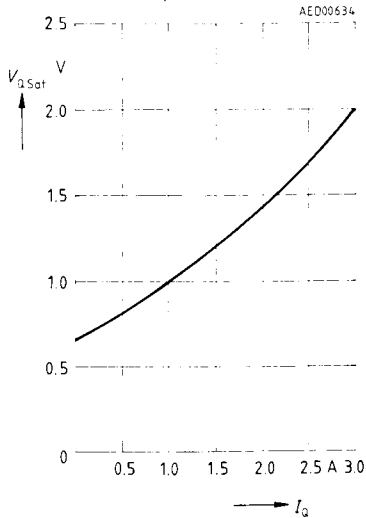
Short-Circuit Current versus Voltage V_{CE} of Power Unit

$T_C = 25\text{ }^\circ\text{C}$



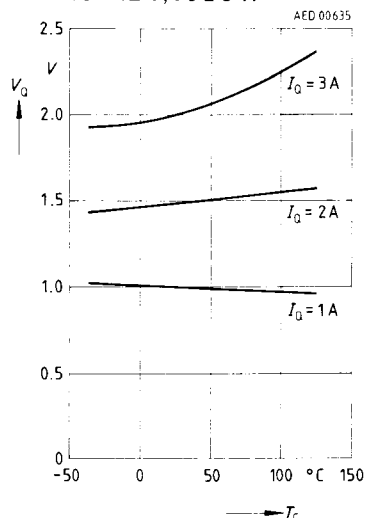
Saturation Voltage V_{QSat} versus Output Current I_Q

$V_S = 12\text{ V}; T_C = 25\text{ }^\circ\text{C}$



Saturation Voltage versus Case Temperature T_C

$V_S = 12\text{ V}; P_D \leq 6\text{ W}$



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