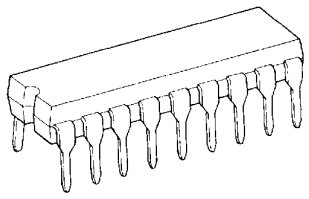
# ULN2803APG,ULN2803AFWG,ULN2804APG,ULN2804AFWG

8ch Darlington Sink Driver

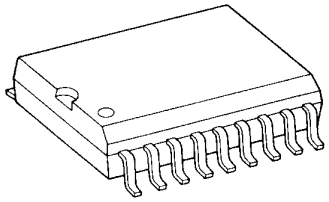
The ULN2803APG / AFWG Series are high−voltage, high−current darlington drivers comprised of eight NPN darlington pairs.
All units feature integral clamp diodes for switching inductive loads.
Applications include relay, hammer, lamp and display (LED) drivers.
The suffix (G) appended to the part number represents a Lead (Pb)-Free product.

ULN2803APG
ULN2804APG



DIP18-P-300-2.54F

ULN2803AFWG
ULN2804AFWG



SOL18-P-300-1.27

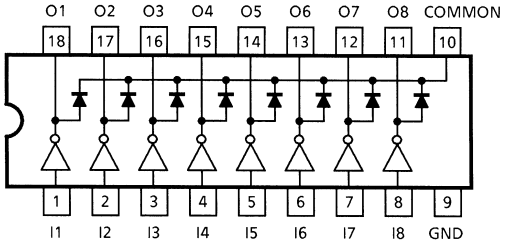
Weight
DIP18−P−300−2.54F: 1.478 g (Typ.)
SOL18−P−300−1.27 : 0.48 g (Typ.)

## Features

- Output current (single output)
  500 mA (Max.)
- High sustaining voltage output
  50 V (Min.)
- Output clamp diodes
- Inputs compatible with various types of logic.
- Package Type−APG : DIP−18pin
- Package Type−AFWG : SOL−18pin

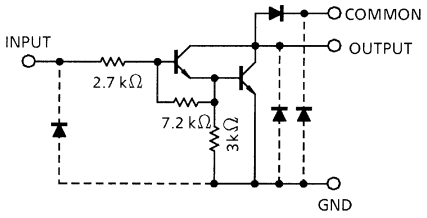
| Type | Input Base Resistor | Designation |
|---|---|---|
| ULN2803APG / AFWG | 2.7 kΩ | TTL, 5 V CMOS |
| ULN2804APG / AFWG | 10.5 kΩ | 6~15 V PMOS, CMOS |

## Pin Connection (top view)

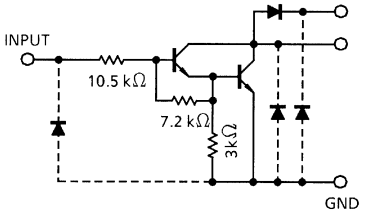


## Schematics (each driver)

ULN2803APG / AFWG




ULN2804APG / AFWG




Note: The input and output parasitic diodes cannot be used as clamp diodes.

## Absolute Maximum Ratings (Ta = 25°C)

| Characteristic | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Output sustaining voltage | | $V_{CE\ (SUS)}$ | −0.5~50 | V |
| Output current | | $I_{OUT}$ | 500 | mA / ch |
| Input voltage | | $V_{IN}$ | −0.5~30 | V |
| Clamp diode reverse voltage | | $V_R$ | 50 | V |
| Clamp diode forward current | | $I_F$ | 500 | mA |
| Power dissipation | APG | $P_D$ | 1.47 | W |
| | AFWG | | 0.92 / 1.31 (Note) | |
| Operating temperature | | $T_{opr}$ | −40~85 | °C |
| Storage temperature | | $T_{stg}$ | −55~150 | °C |

Note: On Glass Epoxy PCB (75 × 114 × 1.6 mm Cu 20%)

## Recommended Operating Conditions (Ta = −40~85°C)

| Characteristic | | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Output sustaining voltage | | $V_{CE\ (SUS)}$ | | 0 | — | 50 | V |
| Output current | APG | $I_{OUT}$ | $T_{pw}$ = 25 ms, Duty = 10%, 8 Circuits | 0 | — | 347 | mA / ch |
| | | | $T_{pw}$ = 25 ms, Duty = 50%, 8 Circuits | 0 | — | 123 | |
| | AFWG | | $T_{pw}$ = 25 ms, Duty = 10%, 8 Circuits | 0 | — | 268 | |
| | | | $T_{pw}$ = 25 ms, Duty = 50%, 8 Circuits | 0 | — | 90 | |
| Input voltage | | $V_{IN}$ | | 0 | — | 30 | V |
| Input voltage (Output on) | ULN2803A | $V_{IN\ (ON)}$ | | 3.5 | — | 30 | V |
| | ULN2804A | | | 8 | — | 30 | |
| Clamp diode reverse voltage | | $V_R$ | | — | — | 50 | V |
| Clamp diode forward current | | $I_F$ | | — | — | 400 | mA |
| Power dissipation | APG | $P_D$ | Ta = 85°C | — | — | 0.76 | W |
| | AFWG | | Ta = 85°C (Note) | — | — | 0.48 | |

Note: On Glass Epoxy PCB (75 × 114 × 1.6 mm Cu 20%)

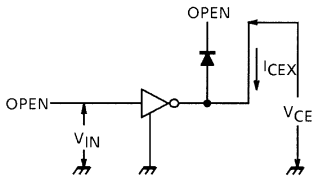
## Electrical Characteristics (Ta = 25°C)

| Characteristic | | Symbol | Test Cir−Cuit | Test Condition | | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|
| Output leakage current | | $I_{CEX}$ | 1 | $V_{CE}$ = 50 V | Ta = 25°C | — | — | 50 | μA |
| | | | | $V_{CE}$ = 50 V | Ta = 85°C | — | — | 100 | |
| | ULN2804A | | | $V_{CE}$ = 50 V | $V_{IN}$ = 1 V | — | — | 500 | |
| Collector−emitter saturation voltage | | VCE (sat) | 2 | $I_{OUT}$ = 350 mA, $I_{IN}$ = 500 μA | | — | 1.3 | 1.6 | V |
| | | | | $I_{OUT}$ = 200 mA, $I_{IN}$ = 350 μA | | — | 1.1 | 1.3 | |
| | | | | $I_{OUT}$ = 100 mA, $I_{IN}$ = 250 μA | | — | 0.9 | 1.1 | |
| Input current | ULN2803A | $I_{IN\ (ON)}$ | 2 | $V_{IN}$ = 3.85 V | | — | 0.93 | 1.35 | mA |
| | ULN2804A | | | $V_{IN}$ = 5 V | | — | 0.35 | 0.5 | |
| | | | | $V_{IN}$ = 12 V | | — | 1.0 | 1.45 | |
| | | $I_{IN\ (OFF)}$ | 4 | $I_{OUT}$ = 500 μA, Ta = 85°C | | 50 | 65 | — | μA |
| Input voltage (Output on) | ULN2803A | $V_{IN\ (ON)}$ | 5 | $V_{CE}$ = 2 V, $I_{OUT}$ = 200 mA | | — | — | 2.4 | V |
| | | | | $V_{CE}$ = 2 V, $I_{OUT}$ = 250 mA | | — | — | 2.7 | |
| | | | | $V_{CE}$ = 2 V, $I_{OUT}$ = 300 mA | | — | — | 3.0 | |
| | ULN2804A | | | $V_{CE}$ = 2 V, $I_{OUT}$ = 125 mA | | — | — | 5.0 | |
| | | | | $V_{CE}$ = 2 V, $I_{OUT}$ = 200 mA | | — | — | 6.0 | |
| | | | | $V_{CE}$ = 2 V, $I_{OUT}$ = 275 mA | | — | — | 7.0 | |
| | | | | $V_{CE}$ = 2 V, $I_{OUT}$ = 350 mA | | — | — | 8.0 | |
| DC current transfer ratio | | $h_{FE}$ | 2 | $V_{CE}$ = 2 V, $I_{OUT}$ = 350 mA | | 1000 | — | — | |
| Clamp diode reverse current | | $I_R$ | 6 | Ta = 25°C | (Note) | — | — | 50 | μA |
| | | | | Ta = 85°C | (Note) | — | — | 100 | |
| Clamp diode forward voltage | | $V_F$ | 7 | $I_F$ = 350 mA | | — | — | 2.0 | V |
| Input capacitance | | $C_{IN}$ | — | | | — | 15 | — | pF |
| Turn−on delay | | $t_{ON}$ | 8 | $R_L$ = 125 Ω, $V_{OUT}$ = 50 V | | — | 0.1 | — | μs |
| Turn−off delay | | $t_{OFF}$ | | $R_L$ = 125 Ω, $V_{OUT}$ = 50 V | | — | 0.2 | — | |

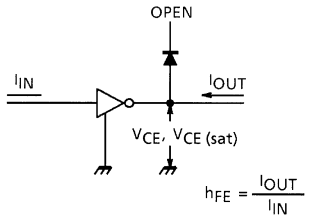
Note: $V_R = V_R$ MAX.

## Test Circuit

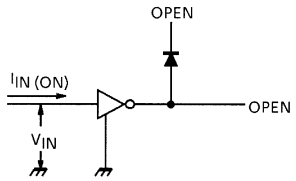
**1. $I_{CEX}$**



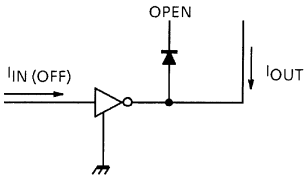

**2. $V_{CE\ (sat)}$, $h_{FE}$**



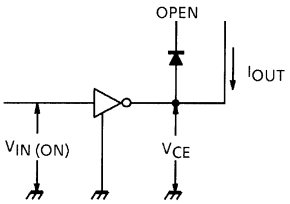

**3. $I_{IN\ (ON)}$**



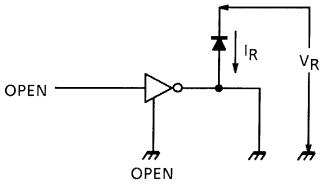

**4. $I_{IN\ (OFF)}$**



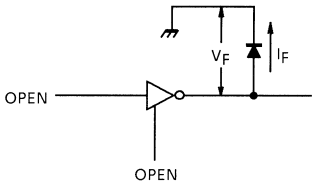

**5. $V_{IN\ (ON)}$**



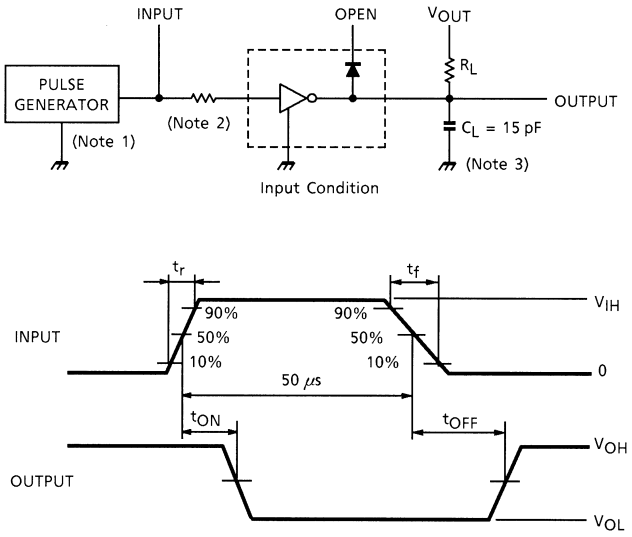

**6. $I_R$**




**7. $V_F$**



### 8. $t_{ON}$, $t_{OFF}$




Note 1: Pulse Width 50 μs, Duty Cycle 10%
Output Impedance 50 Ω, $t_r \leq 5$ ns, $t_f \leq 10$ ns

Note 2: See below.

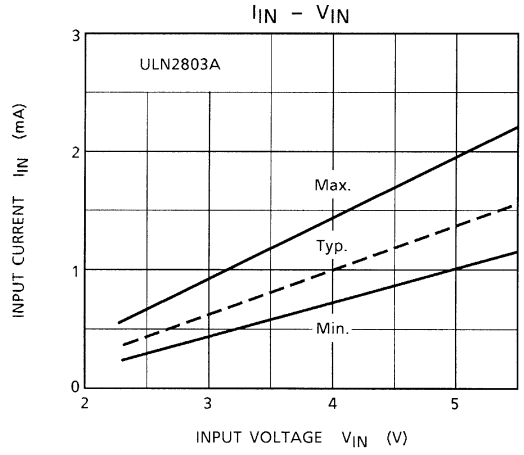
Input Condition

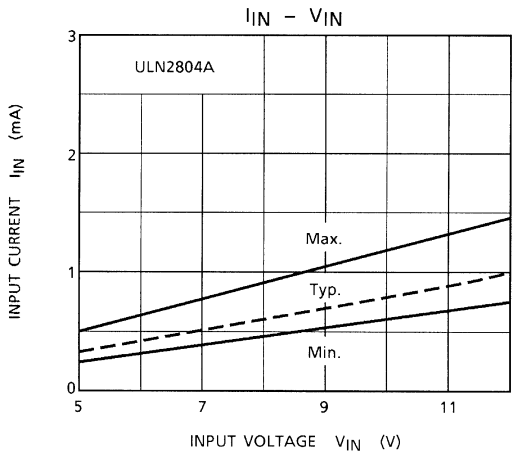
| Type Number | R1 | $V_{IH}$ |
|---|---|---|
| ULN2803A | 0Ω | 3 V |
| ULN2804A | 0Ω | 8 V |

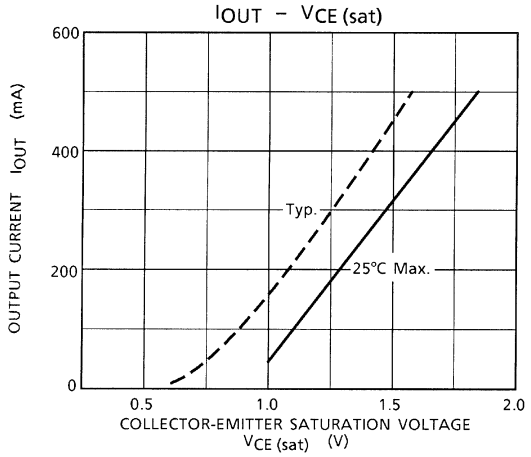
Note 3: $C_L$ includes probe and jig capacitance

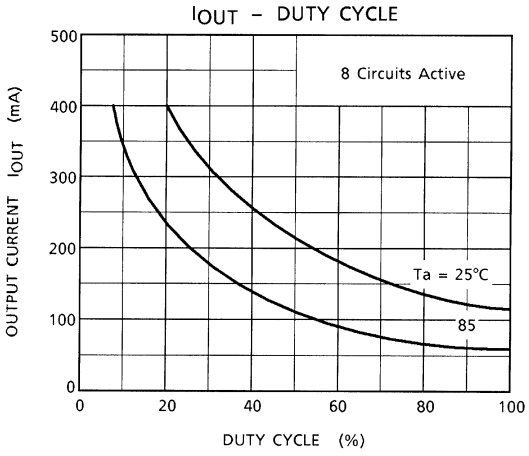
## Precautions for Using

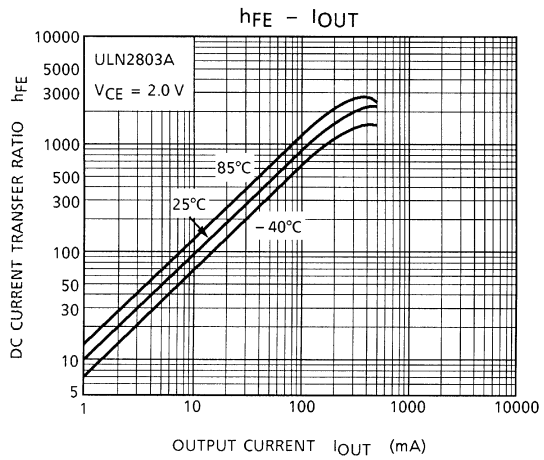
This IC does not integrate protection circuits such as overcurrent and overvoltage protectors.
Thus, if excess current or voltage is applied to the IC, the IC may be damaged. Please design the IC so that excess current or voltage will not be applied to the IC.
Utmost care is necessary in the design of the output line, COMMON and GND line since IC may be destroyed due to short−circuit between outputs, air contamination fault, or fault by improper grounding.

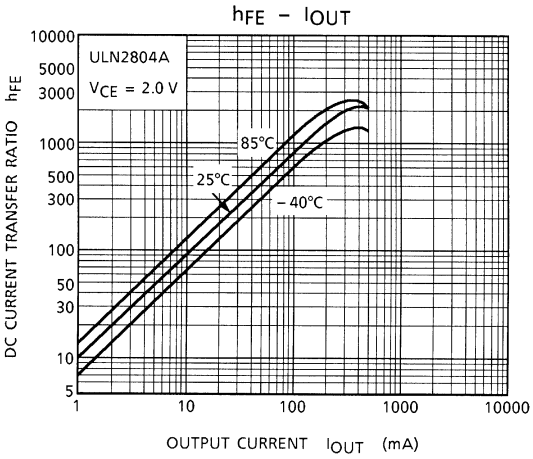

$I_{IN}$ – $V_{IN}$
ULN2803A
Max.
Typ.
Min.
INPUT CURRENT $I_{IN}$ (mA)
INPUT VOLTAGE $V_{IN}$ (V)
0
1
2
3
2
3
4
5

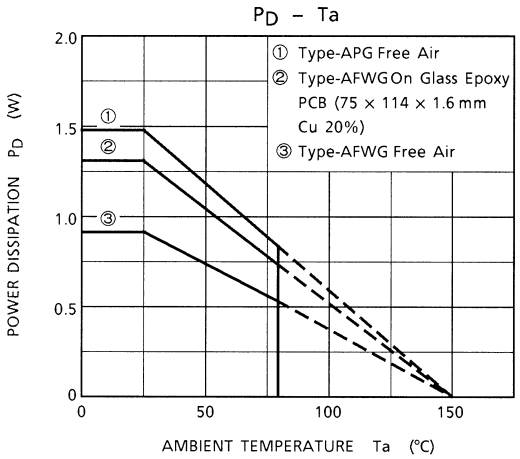

$I_{IN}$ – $V_{IN}$
ULN2804A
Max.
Typ.
Min.
INPUT CURRENT $I_{IN}$ (mA)
INPUT VOLTAGE $V_{IN}$ (V)
0
1
2
3
5
7
9
11


$I_{OUT}$ – $V_{CE\ (sat)}$
Typ.
25°C Max.
OUTPUT CURRENT $I_{OUT}$ (mA)
COLLECTOR-EMITTER SATURATION VOLTAGE
$V_{CE\ (sat)}$ (V)
0
200
400
600
0.5
1.0
1.5
2.0


$I_{OUT}$ – DUTY CYCLE
8 Circuits Active
Ta = 25°C
85
OUTPUT CURRENT $I_{OUT}$ (mA)
DUTY CYCLE (%)
0
100
200
300
400
500
0
20
40
60
80
100


$h_{FE}$ – $I_{OUT}$
ULN2803A
$V_{CE}$ = 2.0 V
85°C
25°C
– 40°C
DC CURRENT TRANSFER RATIO $h_{FE}$
OUTPUT CURRENT $I_{OUT}$ (mA)
5
10
30
50
100
300
500
1000
3000
5000
10000
1
10
100
1000
10000


$h_{FE}$ – $I_{OUT}$
ULN2804A
$V_{CE}$ = 2.0 V
85°C
25°C
– 40°C
DC CURRENT TRANSFER RATIO $h_{FE}$
OUTPUT CURRENT $I_{OUT}$ (mA)
5
10
30
50
100
300
500
1000
3000
5000
10000
1
10
100
1000
10000


$P_D$ – Ta
① Type-APG Free Air
② Type-AFWG On Glass Epoxy PCB (75 × 114 × 1.6 mm Cu 20%)
③ Type-AFWG Free Air
POWER DISSIPATION $P_D$ (W)
2.0
1.5
1.0
0.5
0
0
50
100
150
AMBIENT TEMPERATURE Ta (°C)