## Dual Matched 40 V, 6.0 A, Low VCE(sat) NPN Transistor NSS40301MDR2G

These transistors are part of the onsemi $\mathrm{e}^{2}$ PowerEdge family of Low $\mathrm{V}_{\mathrm{CE}(\mathrm{sat})}$ transistors. They are assembled to create a pair of devices highly matched in all parameters, including ultra low saturation voltage $\mathrm{V}_{\mathrm{CE}(\text { sat })}$, high current gain and Base/Emitter turn on voltage.

Typical applications are current mirrors, differential amplifiers, DC-DC converters and power management in portable and battery powered products such as cellular and cordless phones, PDAs, computers, printers, digital cameras and MP3 players. Other applications are low voltage motor controls in mass storage products such as disc drives and tape drives. In the automotive industry they can be used in air bag deployment and in the instrument cluster. The high current gain allows $\mathrm{e}^{2}$ PowerEdge devices to be driven directly from PMU's control outputs, and the Linear Gain (Beta) makes them ideal components in analog amplifiers.

## Features

- Current Gain Matching to $10 \%$
- Base Emitter Voltage Matched to 2 mV
- This is a $\mathrm{Pb}-$ Free Device

MAXIMUM RATINGS $\left(\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}\right)$

| Rating | Symbol | Max | Unit |
| :--- | :---: | :---: | :---: |
| Collector-Emitter Voltage | $\mathrm{V}_{\text {CEO }}$ | 40 | Vdc |
| Collector-Base Voltage | $\mathrm{V}_{\text {CBO }}$ | 40 | Vdc |
| Emitter-Base Voltage | $\mathrm{V}_{\text {EBO }}$ | 6.0 | Vdc |
| Collector Current - Continuous | $\mathrm{I}_{\mathrm{C}}$ | 3.0 | A |
| Collector Current - Peak | $\mathrm{I}_{\text {CM }}$ | 6.0 | A |
| Electrostatic Discharge | ESD | HBM Class 3B <br> MM Class C |  |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

40 VOLTS
6.0 AMPS

NPN LOW $\mathrm{V}_{\text {CE (sat) }}$ TRANSISTOR EQUIVALENT $\mathrm{R}_{\mathrm{DS}(\mathrm{on})} 44 \mathrm{~m} \Omega$


## ORDERING INFORMATION

| Device | Package | Shipping ${ }^{\dagger}$ |
| :---: | :---: | :---: |
| NSS40301MDR2G | SOIC-8 <br> (Pb-Free) | $2500 /$ <br> Tape \& Reel |
| NSV40301MDR2G |  |  |
|  |  |  |

$\dagger$ For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
| :--- | :---: | :---: | :---: |
| SINGLE HEATED $\mathrm{P}_{\mathrm{D}}$ 576 mW <br> Total Device Dissipation (Note 1) <br> $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ <br> Derate above $25^{\circ} \mathrm{C}$  4.6 $\mathrm{~mW} /{ }^{\circ} \mathrm{C}$ <br> Thermal Resistance, Junction-to-Ambient (Note 1) $\mathrm{R}_{\theta \mathrm{JA}}$ 217 ${ }^{\circ} \mathrm{C} / \mathrm{W}$ <br> Total Device Dissipation (Note 2) $\mathrm{P}_{\mathrm{D}}$ 676 mW <br> $\mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$    <br> Derate above $25^{\circ} \mathrm{C}$  5.4 $\mathrm{~mW} /{ }^{\circ} \mathrm{C}$ <br> Thermal Resistance, Junction-to-Ambient (Note 2) $\mathrm{R}_{\theta J \mathrm{CA}}$ 185 ${ }^{\circ} \mathrm{C} / \mathrm{W}$ |  |  |  |

DUAL HEATED (Note 3)

| Total Device Dissipation (Note 1) $\begin{aligned} & \mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C} \\ & \text { Derate above } 25^{\circ} \mathrm{C} \end{aligned}$ | $P_{\text {D }}$ | $\begin{gathered} 653 \\ 5.2 \end{gathered}$ | $\begin{gathered} \mathrm{mW} \\ \mathrm{~mW} /{ }^{\circ} \mathrm{C} \end{gathered}$ |
| :---: | :---: | :---: | :---: |
| Thermal Resistance, Junction-to-Ambient (Note 1) | $\mathrm{R}_{\text {өJA }}$ | 191 | ${ }^{\circ} \mathrm{C} / \mathrm{W}$ |
| Total Device Dissipation (Note 2) $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ Derate above $25^{\circ} \mathrm{C}$ | $P_{\text {D }}$ | $\begin{gathered} \hline 783 \\ 6.3 \end{gathered}$ | $\begin{gathered} \mathrm{mW} \\ \mathrm{~mW} /{ }^{\circ} \mathrm{C} \end{gathered}$ |
| Thermal Resistance, Junction-to-Ambient (Note 2) | $\mathrm{R}_{\text {өJA }}$ | 160 | ${ }^{\circ} \mathrm{C} / \mathrm{W}$ |
| Junction and Storage Temperature Range | $\mathrm{T}_{\mathrm{J},} \mathrm{T}_{\mathrm{stg}}$ | -55 to +150 | ${ }^{\circ} \mathrm{C}$ |

1. FR-4 @ $10 \mathrm{~mm}^{2}, 1 \mathrm{oz}$. copper traces, still air.
2. FR-4@ $100 \mathrm{~mm}^{2}, 1 \mathrm{oz}$. copper traces, still air.
3. Dual heated values assume total power is the sum of two equally powered devices.

ELECTRICAL CHARACTERISTICS $\left(\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}\right.$ unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
| OFF CHARACTERISTICS |  |  |  |  |  |
| Collector-Emitter Breakdown Voltage $\left(I_{C}=10 \mathrm{mAdc}, \mathrm{I}_{\mathrm{B}}=0\right)$ | $\mathrm{V}_{\text {(BR)CEO }}$ | 40 | - | - | Vdc |
| Collector-Base Breakdown Voltage ( $\mathrm{I}_{\mathrm{C}}=0.1 \mathrm{mAdc}, \mathrm{I}_{\mathrm{E}}=0$ ) | $\mathrm{V}_{\text {(BR) }}$ CBO | 40 | - | - | Vdc |
| Emitter-Base Breakdown Voltage $\left(\mathrm{I}_{\mathrm{E}}=0.1 \mathrm{mAdc}, \mathrm{I}_{\mathrm{C}}=0\right)$ | $\mathrm{V}_{(\mathrm{BR}) \text { EBO }}$ | 6.0 | - | - | Vdc |
| Collector Cutoff Current $\left(\mathrm{V}_{\mathrm{CB}}=40 \mathrm{Vdc}, \mathrm{I}_{\mathrm{E}}=0\right)$ | $I_{\text {cbo }}$ | - | - | 0.1 | $\mu \mathrm{Adc}$ |
| Emitter Cutoff Current $\left(V_{E B}=6.0 \mathrm{Vdc}\right)$ | $\mathrm{I}_{\text {ebo }}$ | - | - | 0.1 | $\mu \mathrm{Adc}$ |

## ON CHARACTERISTICS

| $\begin{aligned} & \hline \text { DC Current Gain (Note 4) } \\ & \left(\mathrm{I}_{\mathrm{C}}=10 \mathrm{~mA}, \mathrm{~V}_{\mathrm{CE}}=2.0 \mathrm{~V}\right) \\ & \left(\mathrm{I}_{\mathrm{C}}=500 \mathrm{~mA}, \mathrm{~V}_{\mathrm{CE}}=2.0 \mathrm{~V}\right) \\ & \left(\mathrm{I}_{\mathrm{C}}=1.0 \mathrm{~A}, \mathrm{~V}_{\mathrm{CE}}=2.0 \mathrm{~V}\right) \\ & \left(\mathrm{I}_{\mathrm{C}}=2.0 \mathrm{~A}, \mathrm{~V}_{\mathrm{CE}}=2.0 \mathrm{~V}\right) \\ & \left(\mathrm{I}_{\mathrm{C}}=2.0 \mathrm{~A}, \mathrm{~V}_{\mathrm{CE}}=2.0 \mathrm{~V}\right)(\text { Note } 5) \end{aligned}$ | $h_{\text {FE }}$ $\mathrm{h}_{\mathrm{FE}(1) / h_{\mathrm{FE}(2)}}$ | $\begin{aligned} & 200 \\ & 200 \\ & 180 \\ & 180 \\ & 0.9 \end{aligned}$ | $\begin{aligned} & 400 \\ & 350 \\ & 340 \\ & 320 \\ & 0.99 \end{aligned}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Collector-Emitter Saturation Voltage (Note 4) $\begin{aligned} & \left(I_{C}=0.1 \mathrm{~A}, I_{\mathrm{B}}=0.010 \mathrm{~A}\right) \\ & \left(I_{C}=1.0 \mathrm{~A}, \mathrm{I}_{\mathrm{B}}=0.100 \mathrm{~A}\right) \\ & \left(I_{C}=1.0 \mathrm{~A}, \mathrm{I}_{\mathrm{B}}=0.010 \mathrm{~A}\right) \\ & \left(I_{C}=2.0 \mathrm{~A}, \mathrm{I}_{\mathrm{B}}=0.200 \mathrm{~A}\right) \end{aligned}$ | $\mathrm{V}_{\text {CE(sat) }}$ |  | $\begin{aligned} & 0.008 \\ & 0.044 \\ & 0.080 \\ & 0.082 \end{aligned}$ | $\begin{aligned} & 0.011 \\ & 0.060 \\ & 0.115 \\ & 0.115 \end{aligned}$ | V |
| $\begin{aligned} & \text { Base-Emitter Saturation Voltage (Note 4) } \\ & \left(I_{C}=1.0 \mathrm{~A}, \mathrm{I}_{\mathrm{B}}=0.01 \mathrm{~A}\right) \end{aligned}$ | $\mathrm{V}_{\mathrm{BE} \text { (sat) }}$ | - | 0.780 | 0.900 | V |
| $\begin{aligned} & \text { Base-Emitter Turn-on Voltage (Note 4) } \\ & \left(I_{\mathrm{C}}=0.1 \mathrm{~A}, \mathrm{~V}_{\mathrm{CE}}=2.0 \mathrm{~V}\right) \\ & \left(\mathrm{I}_{\mathrm{C}}=0.1 \mathrm{~A}, \mathrm{~V}_{\mathrm{CE}}=2.0 \mathrm{~V}\right)(\text { Note } 6) \end{aligned}$ | $\begin{gathered} \mathrm{V}_{\mathrm{BE}(\text { on })} \\ \mathrm{V}_{\mathrm{BE}(1)-}-\mathrm{V}_{\mathrm{BE}(2)} \end{gathered}$ | - | $\begin{gathered} 0.650 \\ 0.3 \end{gathered}$ | $\begin{gathered} 0.750 \\ 2.0 \end{gathered}$ | V <br> mV |
| Cutoff Frequency $\left(\mathrm{I}_{\mathrm{C}}=100 \mathrm{~mA}, \mathrm{~V}_{\mathrm{CE}}=5.0 \mathrm{~V}, \mathrm{f}=100 \mathrm{MHz}\right)$ | $\mathrm{f}_{\mathrm{T}}$ | 100 | - | - | MHz |
| Input Capacitance ( $\mathrm{V}_{\mathrm{EB}}=0.5 \mathrm{~V}, \mathrm{f}=1.0 \mathrm{MHz}$ ) | Cibo | - | 320 | 450 | pF |
| Output Capacitance ( $\mathrm{V}_{\mathrm{CB}}=3.0 \mathrm{~V}, \mathrm{f}=1.0 \mathrm{MHz}$ ) | Cobo | - | 40 | 50 | pF |

## SWITCHING CHARACTERISTICS

| Delay $\left(\mathrm{V}_{\mathrm{CC}}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=750 \mathrm{~mA}, \mathrm{I}_{\mathrm{B} 1}=15 \mathrm{~mA}\right)$ | $\mathrm{t}_{\mathrm{d}}$ | - | - | 100 | ns |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Rise $\left(\mathrm{V}_{\mathrm{CC}}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=750 \mathrm{~mA}, \mathrm{I}_{\mathrm{B} 1}=15 \mathrm{~mA}\right)$ | $\mathrm{t}_{\mathrm{r}}$ | - | - | 100 | ns |
| Storage $\left(\mathrm{V}_{\mathrm{CC}}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=750 \mathrm{~mA}, \mathrm{I}_{\mathrm{B} 1}=15 \mathrm{~mA}\right)$ | $\mathrm{t}_{\mathrm{s}}$ | - | - | 780 | ns |
| Fall $\left(\mathrm{V}_{\mathrm{CC}}=30 \mathrm{~V}, \mathrm{I}_{\mathrm{C}}=750 \mathrm{~mA}, \mathrm{I}_{\mathrm{B} 1}=15 \mathrm{~mA}\right)$ | $\mathrm{t}_{\mathrm{f}}$ | - | - | 110 | ns |

4. Pulsed Condition: Pulse Width $=300 \mu \mathrm{sec}$, Duty Cycle $\leq 2 \%$.
5. $h_{F E(1)} / h_{F E(2)}$ is the ratio of one transistor compared to the other transistor within the same package. The smaller $h_{F E}$ is used as numerator.
6. $\mathrm{V}_{\mathrm{BE}(1)}-\mathrm{V}_{\mathrm{BE}(2)}$ is the absolute difference of one transistor compared to the other transistor within the same package.

$\mathrm{I}_{\mathrm{C}}$, COLLECTOR CURRENT (A)
Figure 1. Collector Emitter Saturation Voltage vs. Collector Current

$\mathrm{I}_{\mathrm{C}}$, COLLECTOR CURRENT (A)
Figure 3. DC Current Gain vs. Collector Current

$I_{\mathrm{C}}$, COLLECTOR CURRENT (A)
Figure 5. Base Emitter Turn-On Voltage vs. Collector Current

$I_{C}$, COLLECTOR CURRENT (A)
Figure 2. Collector Emitter Saturation Voltage vs. Collector Current

$\mathrm{I}_{\mathrm{C}}$, COLLECTOR CURRENT (A)
Figure 4. Base Emitter Saturation Voltage vs. Collector Current

$\mathrm{I}_{\mathrm{b}}$, BASE CURRENT (A)
Figure 6. Saturation Region

TYPICAL CHARACTERISTICS



Figure 9. Safe Operating Area


SOIC-8 NB
CASE 751-07
ISSUE AK
SCALE 1:1
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
. CONTROLLING DIMENSION: MILLIMETER.
2. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
3. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
4. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
5. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS |  | INCHES |  |
| :---: | :---: | :---: | :---: | :---: |
|  | MIN | MAX | MIN | MAX |
|  | 4.80 | 5.00 | 0.189 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.053 | 0.069 |
| D | 0.33 | 0.51 | 0.013 | 0.020 |
| G | 1.27 BSC |  | 0.050 BSC |  |
| H | 0.10 | 0.25 | 0.004 | 0.010 |
| J | 0.19 | 0.25 | 0.007 | 0.010 |
| K | 0.40 | 1.27 | 0.016 | 0.050 |
| M | 0 | $\circ$ | $8^{\circ}$ | 0 |
|  | $\circ$ | 8 |  |  |
| N | 0.25 | 0.50 | 0.010 | 0.020 |
| S | 5.80 | 6.20 | 0.228 | 0.244 |

GENERIC
MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
L Wafer Lot
= Year
= Work Week
= Pb-Free Package
*This information is generic. Please refer to device data sheet for actual part marking. $\mathrm{Pb}-\mathrm{Free}$ indicator, " G " or microdot " $\mathrm{=}$ ", may or may not be present. Some products may not follow the Generic Marking.
*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## STYLES ON PAGE 2

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SOIC-8 NB
CASE 751-07
ISSUE AK
DATE 16 FEB 2011

STYLE

| PIN 1. | EMITTER |
| ---: | :--- |
| 2. | COLLECTOR |
| 3. | COLLECTOR |
| 4. | EMITTER |
| 5. | EMITTER |
| 6. | BASE |
| 7. | BASE |
| 8. | EMITTER |
| STYLE 5: |  |
| PIN 1. | DRAIN |
| 2. | DRAIN |
| 3. | DRAIN |
| 4. | DRAIN |
| 5. | GATE |
| 6. | GATE |
| 7. | SOURCE |
| 8. | SOURCE |

STYLE 9:
PIN 1. EMITTER, COMMON
COLLECTOR, DIE \#1 COLLECTOR, DIE \#2 EMITTER, COMMON EMITTER, COMMON BASE, DIE \#2
BASE, DIE \#1
8. EMITTER, COMMON

STYLE 13:
PIN 1. N.C.
2. SOURCE
3. SOURCE

GATE
DRAIN
DRAIN
DRAIN
8. DRAIN

STYLE 17:
PIN 1. VCC
2. V2OUT

V1OUT
TXE
RXE
VEE
7. GND
8. ACC

STYLE 21:
PIN 1. CATHODE 1
2. CATHODE 2
3. CATHODE 3

CATHODE 4
CATHODE 5
6. COMMON ANODE
7. COMMON ANODE
8. CATHODE 6

STYLE 25:
PIN 1. VIN
2. $N / C$

REXT
GND
IOUT
IOUT
IOUT
8. IOUT

## STYLE 29:

PIN 1. BASE, DIE \#
EMITTER, \#1
BASE, \#2
. EMITTER, \#2
5. COLLECTOR, \#2
6. COLLECTOR, \#2
7. COLLECTOR, \#1
7. COLLECTOR, \#1

STYLE
PIN 1. COLIECTOR, DIE,
2. COLLECTOR, \#1
3. COLLECTOR, \#2

COLLECTOR, \#2
BASE, \#2
. EMITTER, \#2
7. BASE, \#1
8. EMITTER, \#1

STYLE 6:
PIN 1. SOURCE
DRAIN
3. DRAIN
4. SOURCE

SOURCE
6. GATE
7. GATE
8. SOURCE

STYLE 10:
PIN 1. GROUND
2. BIAS 1
3. OUTPUT
4. GROUND

GROUND
BIAS 2
7. INPUT
8. GROUND

STYLE 14:
PIN 1. N-SOURCE
2. N-GATE

P-SOURCE
P-GATE
5.DRAIN
6. P-DRAIN
7. N-DRAIN
8. N -DRAIN

STYLE 18
PIN 1. ANODE
2. ANODE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. CATHODE
8. CATHODE

STYLE 22 :
PIN 1. I/O LINE
2. COMMON CATHODE/VCC
3. COMMON CATHODE/VCC
4. I/O LINE 3
5. COMMON ANODE/GND
6. I/O LINE 4
7. I/O LINE 5
8. COMMON ANODE/GND

STYLE 26:
PIN 1. GND
2. $\mathrm{dv} / \mathrm{dt}$
3. ENABLE
4. ILIMIT
5. SOURCE

SOURCE
7. SOURCE
8. VCC

STYLE 30:
PIN 1. DRAIN 1
2. DRAIN 1
. GATE 2
4. SOURCE 2
5. SOURCE 1/DRAIN 2
. SOURCE 1/DRAIN 2
SOURCE 1/DRAIN 2
8. GATE 1

STYLE 3
STYLE

1. DRAIN, DIE
2. DRAIN, \#1
3. DRAIN, \#
4. DRAIN, \#2
5. DRAIN, \#2
6. GATE, \#2
7. GATE, \#1
8. SOURCE, \#1

## STYLE 7

PIN 1. INPUT
2. EXTERNAL BYPASS
3. THIRD STAGE SOURCE
4. GROUND
5. DRAIN
6. GATE 3
7. SECOND STAGE Vd
8. FIRST STAGE Vd

## STYLE 11:

PIN 1. SOURCE
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN
8. DRAIN 1

## STYLE 15:

PIN 1. ANODE 1
2. ANODE 1
3. ANODE 1
4. ANODE 1
5. CATHODE, COMMON
6. CATHODE, COMMON
7. CATHODE, COMMON
8. CATHODE, COMMON

## STYLE 19:

PIN 1. SOURCE
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN
6. MIRROR 2
7. DRAIN 1
8. MIRROR 1

## STYLE 23:

PIN 1. LINE 1 IN
2. COMMON ANODE/GND
3. COMMON ANODE/GND
4. LINE 2 IN
5. LINE 2 OUT
6. COMMON ANODE/GND
7. COMMON ANODE/GND
8. LINE 1 OUT

STYLE 27:
PIN 1. ILIMIT
2. OVLO
3. UVLO
4. INPUT+
5. INPUT+
5. SOURCE
6. SOURCE
7. SOURCE
8. DRAIN

STYLE 4:
PIN 1. ANODE
2. ANODE
3. ANODE
4. ANODE
5. ANODE
6. ANODE
8. COMMON CATHODE

## STYLE 8:

PIN 1. COLLECTOR, DIE \#1
2. BASE, \#1
3. BASE, \#2
4. COLLECTOR, \#2
5. COLLECTOR, \#2
6. EMITTER, \#2
7. EMITTER, \#1
8. COLLECTOR, \#1

## STYLE 12

PIN 1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

## STYLE 16:

PIN 1. EMITTER, DIE \#1
2. BASE, DIE \#1
3. EMITTER, DIE \#2
3. EMITTER, DIE
4. BASE, DIE \#2
4. BASE, DIE \#2
6. COLLECTOR, DIE \#2
7. COLLECTOR, DIE \#1
8. COLLECTOR, DIE \#1

## STYLE 20:

PIN 1. SOURCE (N)
2. GATE (N)
3. SOURCE (P)
4. GATE (P)
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 24
PIN 1. BASE
2. EMITTER
3. COLLECTOR/ANODE
4. COLLECTOR/ANODE
5. CATHODE
6. CATHODE
7. COLLECTOR/ANODE
8. COLLECTOR/ANODE

## STYLE 28:

PIN 1. SW_TO_GND
2. DA $\bar{S} I C \bar{O} F F$
3. DASIC_SW_DET
4. GND
5. V_MON
6. VBUULK
7. VBULK
8. VIN

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