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[^0]
## FAIRCHILD

## FDZ2040L Integrated Load Switch

## Features

- Optimized for Low-Voltage Core ICs in Portable Systems
- Very Small Package Dimension: WL-CSP $0.8 \times 0.8 \times 0.5 \mathrm{~mm}^{3}$
- Current $=1.2 \mathrm{~A}, \mathrm{~V}_{\mathrm{IN}}$ max. $=4 \mathrm{~V}$
- Current $=2 \mathrm{~A}, \mathrm{~V}_{\mathrm{IN}}$ max. $=4 \mathrm{~V}$ (Pulsed)
- $R_{D S(O N)}=80 \mathrm{~m} \Omega$ at $\mathrm{V}_{\mathrm{ON}}=0 \mathrm{~V}, \mathrm{~V}_{\mathrm{IN}}=4 \mathrm{~V}$
- $\quad R_{\mathrm{DS}(\mathrm{ON})}=85 \mathrm{~m} \Omega$ at $\mathrm{V}_{\mathrm{ON}}=0 \mathrm{~V}, \mathrm{~V}_{\mathbb{I N}}=3.6 \mathrm{~V}$
- $R_{D S(O N)}=90 \mathrm{~m} \Omega$ at $\mathrm{V}_{\mathrm{ON}}=0 \mathrm{~V}, \mathrm{~V}_{\mathrm{IN}}=3 \mathrm{~V}$
- RoHS Compliant



## General Description

This device is particularly suited for compact power management in portable applications where 1.6 V to 4 V input and 1.2 A output current capability are needed. This load switch integrates a level-shifting function that drives a P-channel power MOSFET in the very small 0.8 $\times 0.8 \times 0.5 \mathrm{~mm}^{3}$ WL-CSP package.

## Applications

- Load Switch
- Power Management in Portable Applications


BOTTOM


TOP

## Ordering Information

| Part <br> Number | Device <br> Marking | Ball <br> Pitch | Operating <br> Temperature Range | Switch | Package | Packing <br> Method |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| FDZ2040L | ZL | 0.4 mm | -25 to $75^{\circ} \mathrm{C}$ | $80 \mathrm{~m} \Omega$, <br> P-Channel <br> MOSFET | $0.8 \times 0.8 \times 0.5 \mathrm{~mm}^{3}$ <br> WL-CSP | Tape and <br> Reel |

## Application Diagram and Block Diagram



Figure 1. Block Diagram and Typical Application Pin Configuration


Top View: Bumps Facing Down Bottom View: Bumps Facing Up

Figure 2. Pin Assignment

## Pin Definitions

| Pin \# | Name | Description |
| :---: | :---: | :--- |
| A1 | $V_{\text {IN }}$ | Supply Input: Input to the load switch |
| A2 | V out | Switch Output: Output of the load switch |
| B1 | ON | ON/OFF Control Input, Active LOW |
| B2 | GND | Ground |

Absolute Maximum Ratings

| Parameter |  | Min. | Max. | Unit |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{IN}}, \mathrm{V}_{\text {out }}$, ON to GND |  | -0.3 | 4.2 | V |
| $\mathrm{I}_{\text {out }}$ - Load Current (Continuous) ${ }^{(1 a)}$ |  |  | 1.2 | A |
| Iout - Load Current (Pulsed) ${ }^{(2)}$ |  |  | 2 | A |
| Power Dissipation @ $\mathrm{TA}^{\text {a }}=25^{\circ} \mathrm{C}^{(1 \mathrm{a})}$ |  |  | 0.9 | W |
| Operating Temperature Range |  | -40 | 105 | ${ }^{\circ} \mathrm{C}$ |
| Storage Temperature |  | -65 | 150 | ${ }^{\circ} \mathrm{C}$ |
| Electrostatic Discharge Capability | Human Body Model, JESD22-A114 | 8 |  | kV |
|  | Charged Device Model, JESD22-C101 | 2 |  |  |

## Thermal Characteristics

| Parameter | Min. | Max. | Unit |
| :--- | :---: | :---: | :---: |
| Thermal Resistance, Junction to Ambient ${ }^{\text {(1a) }}$ |  | 117 | ${ }^{\circ} \mathrm{C} / \mathrm{W}$ |

Recommended Operating Conditions

| Parameter | Min. | Max. | Unit |
| :--- | :---: | :---: | :---: |
| $\mathrm{V}_{\mathbb{I N}}$ | 1.6 | 4.0 | V |
| Ambient Operating Temperature, $\mathrm{T}_{\mathrm{A}}$ | -25 | 75 | ${ }^{\circ} \mathrm{C}$ |

## Notes:

1. R ReJA is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. R $\mathrm{R}_{\text {өc }}$ is guaranteed by design while $R_{\text {өJA }}$ is determined by the user's board design.

b. $277^{\circ} \mathrm{C} / \mathrm{W}$ when mounted on a minimum pad of 2 oz copper.
2. Pulse Test: Pulse Width $<300 \mu \mathrm{~s}$, Duty Cycle $<2.0 \%$.

## Electrical Characteristics

$\mathrm{T}_{\mathrm{J}}=25^{\circ} \mathrm{C}$ unless otherwise noted.

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\text {IN }}$ | Operation Voltage |  | 1.6 |  | 4.0 | V |
| $\mathrm{V}_{\text {IL }}$ | ON Input Logic LOW Voltage | $\mathrm{V}_{\mathrm{IN}}=1.6 \mathrm{~V}$, Ramp-Down $\mathrm{V}_{\text {on }}$ from 1 V to $0 \mathrm{~V}, \mathrm{~V}_{\text {Out }} \mathrm{LOW}$ to $\mathrm{HIGH}, \mathrm{T}_{\mathrm{J}}=-25$ to $75^{\circ} \mathrm{C}$ |  |  | 0.35 | V |
|  |  | $\mathrm{V}_{\text {IN }}=4 \mathrm{~V}$, Ramp-Down $\mathrm{V}_{\mathrm{ON}}$ from 1 V to $0 \mathrm{~V}, \mathrm{~V}_{\text {OUt }}$ LOW to HIGH, $\mathrm{T}_{\mathrm{J}}=-25$ to $75^{\circ} \mathrm{C}$ |  |  | 0.35 | V |
| $\mathrm{V}_{\mathrm{IH}}$ | ON Input Logic HIGH Voltage | $\mathrm{V}_{\mathrm{IN}}=1.6 \mathrm{~V}$, Ramp-Up $\mathrm{V}_{\text {ON }}$ from 0 V to 1 V , $\mathrm{V}_{\text {OUT }} \mathrm{HIGH}$ to LOW, $\mathrm{T}_{\mathrm{J}}=-25$ to $75^{\circ} \mathrm{C}$ | 1.35 |  |  | V |
|  |  | $\mathrm{V}_{\text {IN }}=4 \mathrm{~V}$, Ramp-Up $\mathrm{V}_{\text {on }}$ from 0 V to $1 \mathrm{~V}, \mathrm{~V}_{\text {Out }} \mathrm{HIGH}$ to LOW, $\mathrm{T}_{\mathrm{J}}=-25$ to $75^{\circ} \mathrm{C}$ | 1.35 |  |  | V |
| $\mathrm{I}_{\mathrm{Q}}$ | Quiescent Current | $\begin{aligned} & \mathrm{V}_{\mathrm{IN}}=3 \mathrm{~V}, \mathrm{~V}_{\text {ON }}=0.35 \mathrm{~V}, \text { I OUT }=0 \mathrm{~A}, \\ & \mathrm{~T}_{\mathrm{J}}=-25 \text { to } 75^{\circ} \mathrm{C} \end{aligned}$ |  | 1.55 | 2.50 | $\mu \mathrm{A}$ |
| IQ _off | Off Supply Current | $\begin{aligned} & \mathrm{V}_{\text {IN }}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{ON}}=1.3 \mathrm{~V} \text {, lout }=0 \mathrm{~A}, \\ & \mathrm{~T}_{\mathrm{J}}=-25 \text { to } 75^{\circ} \mathrm{C} \end{aligned}$ |  | 2.4 | 6.5 | $\mu \mathrm{A}$ |
| ISD_off | Off Switch Current | $\begin{aligned} & \mathrm{V}_{\text {IN }}=3 \mathrm{~V}, \mathrm{~V}_{\text {ON }}=1.3 \mathrm{~V}, \mathrm{~V}_{\text {OUT }}=0 \mathrm{~V}, \\ & \mathrm{~T}_{\mathrm{J}}=-25 \text { to } 75^{\circ} \mathrm{C} \end{aligned}$ |  | 0.1 | 3.5 | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\mathrm{Q} \text { _off }}$ (VON float) | Off Supply Current with ON Pin Floating | $\mathrm{V}_{\text {IN }}=3 \mathrm{~V}, \mathrm{~V}_{\text {ON }}=$ Floating, $\mathrm{l}_{\text {OUT }}=0 \mathrm{~A}$ |  | 1.6 | 2.3 | $\mu \mathrm{A}$ |
|  |  | $\begin{aligned} & \mathrm{V}_{\text {IN }}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{ON}}=\text { Floating, } \\ & \mathrm{T}_{\mathrm{J}}=-25 \text { to } 75^{\circ} \mathrm{C} \end{aligned}$ |  | 1.6 | 4.0 | $\mu \mathrm{A}$ |
| Rpull-down | Output Pull-Down Resistance | $\mathrm{V}_{\text {IN }}=3 \mathrm{~V}, \mathrm{l}_{\text {OUT }}=10 \mathrm{~mA}$ |  | 22 |  | $\Omega$ |
| $\mathrm{R}_{\mathrm{DS}(\mathrm{ON})}$ | On Resistance | $\mathrm{V}_{\text {IN }}=1.6 \mathrm{~V}, \mathrm{~V}_{\text {ON }}=0 \mathrm{~V}, \mathrm{l}_{\text {OUT }}=300 \mathrm{~m} \mathrm{~A}$ |  | 68 | 120 | $\mathrm{m} \Omega$ |
|  |  | $\mathrm{V}_{\text {IN }}=3 \mathrm{~V}, \mathrm{~V}_{\text {ON }}=0 \mathrm{~V}$, I IOUT $=300 \mathrm{~m} \mathrm{~A}$ |  | 50 | 90 |  |
|  |  | $\mathrm{V}_{\text {IN }}=3.6 \mathrm{~V}, \mathrm{~V}_{\text {ON }}=0 \mathrm{~V}$, lout $=300 \mathrm{~mA}$ |  | 48 | 85 |  |
|  |  | $\begin{aligned} & \mathrm{V}_{\text {IN }}=4 \mathrm{~V}, \mathrm{~V}_{\mathrm{ON}}=0 \mathrm{~V}, \text { I lout }=300 \mathrm{~mA}, \\ & \mathrm{~T}_{\mathrm{J}}=-25 \text { to } 75^{\circ} \mathrm{C} \end{aligned}$ |  | 47 | 80 |  |
| $\mathrm{Cl}_{\text {V-ON(INP) }}$ | ON Input Capacitance | $\mathrm{T}_{J}=-25$ to $75^{\circ} \mathrm{C}$ |  |  | 5 | pF |
| Ion(PULL-UP) | ON Pull-Up Current | $\mathrm{V}_{\mathrm{IN}}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{ON}}=0 \mathrm{~V}, \mathrm{~T}_{J}=-25$ to $75^{\circ} \mathrm{C}$ | 0.30 | 0.76 | 1.20 | $\mu \mathrm{A}$ |

## Switching Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{t}_{\text {on }}$ | Turn-On Time (Von $50 \%$ to $V_{\text {OUt }} 90 \%$ ) | $\mathrm{V}_{\text {IN }}=3 \mathrm{~V}, \mathrm{~V}_{\mathrm{ON}}=0 \mathrm{~V}$ as Logic LOW and 1.3 V as Logic HIGH, Cout $=1 \mathrm{nF}, \mathrm{R}_{\mathrm{L}}=$ $30 \Omega, T_{J}=-25$ to $75^{\circ} \mathrm{C}$ |  | 45 | 150 | ns |
| $t_{\text {don }}$ | Turn-On Delay (Von $50 \%$ to Vout 10\%) |  |  | 35 | 100 | ns |
| $t_{\text {rise }}$ | Turn-On Rise Time (Vout $10 \%$ to $90 \%$ ) |  |  | 10 | 50 | ns |
| $\mathrm{t}_{\text {off }}$ | Turn-Off Time ( $\mathrm{V}_{\mathrm{ON}} 50 \%$ to $V_{\text {OUT }} 10 \%$ ) |  |  | 60 | 150 | ns |
| $\mathrm{t}_{\text {doff }}$ | Turn-Off Delay (Von 50\% to Vout 90\%) |  |  | 25 | 100 | ns |
| $t_{\text {fall }}$ | Turn-Off Fall Time (Vout $90 \%$ to 10\%) |  |  | 35 | 65 | ns |
| $t_{\text {don }}-t_{\text {doff }}$ | Turn-On Turn-Off Delay Delta |  |  |  | 50 | ns |

Typical Performance Characteristics


Figure 3.Quiescent Current vs. Temperature


Figure 5.Off Supply Current vs. Temperature


Figure 7. Off Supply Current (Von Float) vs. Temperature


Figure 4. Quiescent Current vs. Supply Voltage


Figure 6. Off Supply Current vs. Supply Voltage


Figure 8. Off Supply Current (Von ${ }_{\text {ON }}$ Float) vs. Supply Voltage

Typical Performance Characteristics (Continued)


Figure 9. ON Pin Pull-Up Current vs. Temperature


Figure 11. ON Pin Logic HIGH Voltage vs. Temperature


Figure 13. ON Pin Logic LOW Voltage vs. Temperature


Figure 10. ON Pin Pull-Up Current vs. Supply Voltage


Figure 12. ON Pin Logic HIGH Voltage vs. Supply Voltage


Figure 14. ON Pin Logic LOW Voltage vs. Supply Voltage

Typical Performance Characteristics (Continued)


Figure 15. Output Pull-Down Resistance vs. Temperature


Figure 17. Static Drain-to-Source ON Resistance vs. Temperature


Figure 16. Output Pull-Down Resistance vs. Supply Voltage


Figure 18. Static Drain-to-Source ON Resistance vs. Supply Voltage

## Typical Performance Characteristics (Continued)


$\mathrm{V}_{\text {IN }}=3.3 \mathrm{~V}, \mathrm{~V}_{\mathrm{ON}}=0 \mathrm{~V}, \mathrm{C}_{\text {IN }}=1 \mu \mathrm{~F}, \mathrm{C}_{\text {out }}=1 \mathrm{nF}, \mathrm{R}_{\mathrm{L}}=30 \Omega$
Figure 19. $t_{\mathrm{ON}}$ Response

$\mathrm{V}_{\mathrm{IN}}=3.3 \mathrm{~V}, \mathrm{~V}_{\text {ON }}=0 \mathrm{~V}, \mathrm{C}_{\text {IN }}=1 \mu \mathrm{~F}, \mathrm{C}_{\text {out }}=1 \mathrm{nF}, \mathrm{R}_{\mathrm{L}}=30 \Omega$
Figure 20. $t_{\text {off }}$ Response

## Operation Description

The FDZ2040L is a low- $R_{D s(O N)} P$-channel load switch packaged in space-saving $0.8 \times 0.8 \mathrm{WL}-\mathrm{CSP}$.
The core of the device is an $80 \mathrm{~m} \Omega \mathrm{P}$-channel MOSFET and capable of functioning over a wide input operating range of $1.6 \mathrm{~V}-4 \mathrm{~V}$.

## Applications Information



Figure 21. Typical Application

## Input Capacitor

To reduce device inrush current effect, a $0.1 \mu \mathrm{~F}$ ceramic capacitor, $\mathrm{C}_{\mathrm{IN}}$ is recommended close to the $\mathrm{V}_{\mathbb{I}}$ pin. A higher value of $\mathrm{C}_{\mathrm{IN}}$ can be used to further reduce the voltage drop experienced as the switch is turned on into a large capacitive load.

## Output Capacitor

FDZ2040L switch works without an output capacitor. If parasitic board inductance forces $V_{\text {Out }}$ below GND when switching off, a 1 nF capacitor, Cout, should be placed between VOUT and GND.

## Note:

3. The intrinsic diode for P -channel load switch would conduct if $\mathrm{V}_{\text {out }}$ is greater than $\mathrm{V}_{\mathbb{1}}$, by a diode drop.

## Evaluation Board Layout



Figure 22. Top View


Figure 23. Bottom View

## Physical Dimensions



NOTES:
A. NO JEDEC REGISTRATION APPLIES.
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCE PER ASME Y14.5M, 1994.
D. DATUM C IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.
e. PACKAGE NOMINAL HEIGHT IS 500 MICRONS $\pm 39$ MICRONS (461-539 MICRONS).
F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.
G. DRAWING FILNAME: MKT-UC004AFrev1.

Figure 24. 4 Ball, WLCSP, 2 X 2 Array, 0.4 mm Pitch, $250 \mu \mathrm{~m}$ Ball

## Product-Specific Dimensions

| Product | D | E | $\mathbf{X}$ | Y |
| :---: | :---: | :---: | :---: | :---: |
| FDZ2040L | $0.8 \pm 0.03 \mathrm{~mm}$ | $0.8 \pm 0.03 \mathrm{~mm}$ | 0.21 mm | 0.21 mm |

[^1]
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TCK111G,LF(S FPF1018 DS1222 TCK2065G,LF SZNCP3712ASNT3G MIC2033-05BYMT-T5 MIC2033-12AYMT-T5 MIC2033-05BYM6-T5 SLG5NT1437VTR SZNCP3712ASNT1G DML1008LDS-7 KTS1670EDA-TR KTS1640QGDV-TR KTS1641QGDV-TR NCV459MNWTBG FPF2260ATMX U6513A MIC2012YM-TR NCP45780IMN24RTWG AP22953CW12-7 MAX14919AUP+T MAX14919ATP+ KTS1697AEOAB-TR TCK207AN,LF BD2227G-LBTR TCK126BG,LF XC8111AAA010R-G MPQ5072GG-AEC1-P TCK128BG,LF XC8110AA018R-G XC8110AA010R-G XC8111AA018R-G MC33882PEP TPS2104DBVR MIC2098-1YMT-TR MIC94062YMT TR MP6231DN-LF MIC2015-1.2YM6 TR MIC2075-2YM MIC94068YML-TR SIP32461DB-T2-GE1 NCP335FCT2G TCK105G,LF(S AP2411S-13 AP2151DSG-13 AP2172MPG-13 MIC94094YC6-TR MIC94093YC6-TR MIC94064YC6-TR MIC94061YMT-TR


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