

## Application Note

### AP22652/53 Application Information and Demo Board User Guide

---

#### **Description**

The AP22652 and AP22653 are single channel precision adjustable current-limited switches optimized for applications that require precision current limiting, or to provide up to 2.1 A of continuous load current during heavy loads/short circuits. These devices offer a programmable current-limit threshold between 125mA and 2665mA (typ) via an external resistor. Current limit accuracy  $\pm 10\%$  can be achieved at high current-limit settings. The rise and fall times are controlled to minimize current surges during turn on/off.

The devices have fast short-circuit response time for improved overall system robustness. They provide a complete protection solution for applications subject to heavy capacitive loads and the prospect of short circuit, offering reverse current blocking and limiting, over-current, over-temperature and short-circuit protection, as well as controlled rise time and under-voltage lockout functionality. A 6ms deglitch capability on the open-drain Flag output prevents false over-current reporting and does not require any external components.

AP22652 and AP22653 limits the output current to a safe level when the output current exceeds current-limit threshold.

All devices are available in SOT26 and W-DFN2020-6 packages.

#### **Features**

- Up to 2.1A Maximum Load Current
- Accurate Adjustable Current Limit, 125mA-2665mA
- $\pm 7\%$  Accurate Adjustable Current Limit, 1.735A with  $R_{LIM} = 15k\Omega$
- Constant-Current (AP22652, AP22653) During Over-Current
- Fast Short-Circuit Response Time: 5 $\mu$ s (typ)

- Reverse Current Blocking During Shutdown and Reverse Current Limiting During Enable
- Operating Range: 3.0V - 5.5V
- Built-in Soft-Start with 0.5ms Typical Rise Time
- Over-Current, Output Over-Voltage and Thermal Protection
- Fault Report (FAULT) with Blanking Time
- ESD Protection: 2kV HBM, 500V CDM
- Active Low (AP22652) or Active High (AP22653) Enable
- Ambient Temperature Range: -40°C to +85°C
- SOT26 and W-DFN2020-6 Package: Available in "Green" Molding Compound (No Br, Sb)
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- 15kV ESD Protection per IEC 61000-4-2 (with ext. capacitance)
- UL Recognized, File Number E322375, Vol. 1
- IEC60950-1 CB Scheme Certified

#### **Applications**

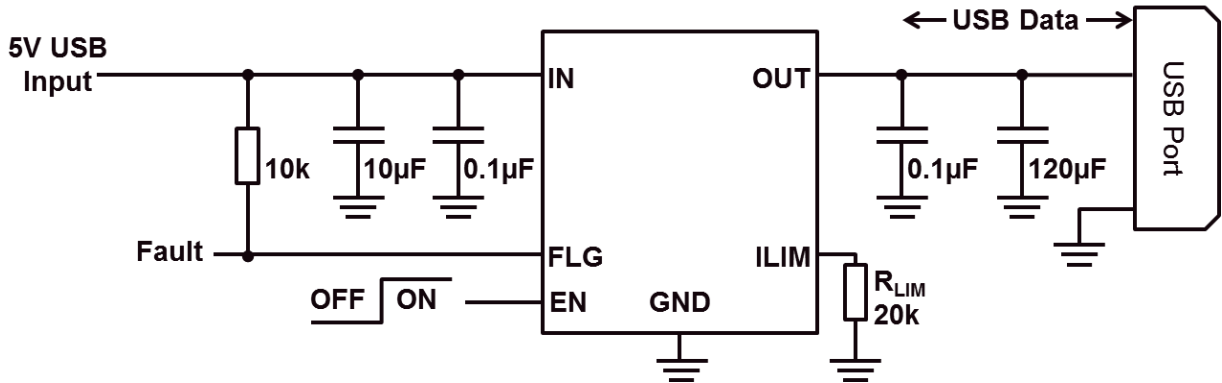
- Set-Top Boxes
- LCD TVs & Monitors
- Residential Gateways
- Laptops, Desktops, Servers, e-Readers, Printers, Docking Stations, HUBs

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.  
2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.  
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds

## Application Note

### AP22652/53 Application Information and Demo Board User Guide

#### Typical Applications Circuit



120µF Output Capacitance is a Requirement of USB

#### Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit	
ESD	HBM	Human Body Model ESD Protection	2	kV
	CDM	Charged Device Model ESD Protection	500	V
	IEC system level	Surges per IEC61000-4-2, 1999 Applied to Output Terminals of EVM	15	kV
$V_{IN}, V_{OUT}, V_{FAULT}, V_{ILIM}, V_{EN}, \overline{V_{EN}}$	Voltage on IN, OUT, $\overline{FAULT}$ , ILIM, EN, $\overline{EN}$	-0.3 to +6.0	V	
—	Continuous $\overline{FAULT}$ Sink Current	25	mA	
—	ILIM Source Current	1	mA	
$I_{LOAD}$	Maximum Continuous Load Current	Internal Limited	A	
$T_{J(MAX)}$	Maximum Junction Temperature	-40 to +150	°C	
$T_{ST}$	Storage Temperature Range	-65 to +150	°C	

This application note contains new product information. Diodes, Inc. reserves the right to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sale of the product.

## Application Note

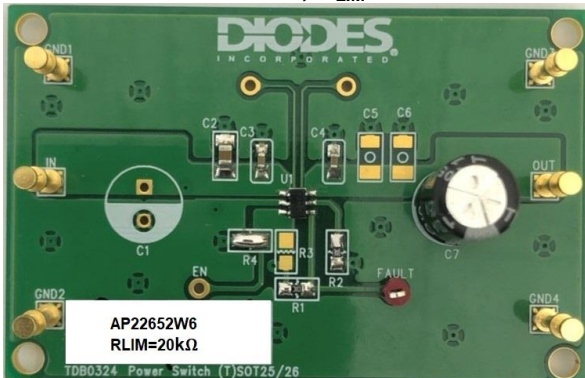
### AP22652/53 Application Information and Demo Board User Guide

#### Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
$V_{IN}$	Input Voltage	3	5.5	V
$I_{OUT}$	Continuous Output Current ( $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ )	0	2.1	A
$V_{EN}, V_{\overline{EN}}$	Enable Voltage	0	5.5	V
$V_{IH}$	High-Level Input Voltage on EN or $\overline{EN}$	1.5	$V_{IN}$	V
$V_{IL}$	Low-Level Input Voltage on EN or $\overline{EN}$	0	0.4	V
$R_{LIM}$	Current-Limit Threshold Resistor Range (1% initial tolerance)	10	210	k $\Omega$
$I_O$	Continuous $\overline{FAULT}$ Sink Current	0	10	mA
---	Input De-Coupling Capacitance, IN to GND	0.1	-	$\mu\text{F}$
$T_A$	Operating Ambient Temperature	-40	+85	$^{\circ}\text{C}$
$T_J$	Operating Junction Temperature	-40	+125	$^{\circ}\text{C}$

#### Evaluation Board

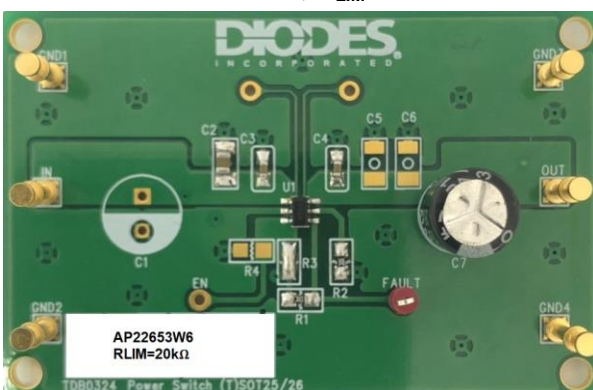
AP22652W6,  $R_{LIM}=20\text{k}\Omega$



AP22652FDZ,  $R_{LIM}=20\text{k}\Omega$



AP22653W6,  $R_{LIM}=20\text{k}\Omega$



AP22653FDZ,  $R_{LIM}=20\text{k}\Omega$



This application note contains new product information. Diodes, Inc. reserves the right to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sale of the product.

## Application Note

### AP22652/53 Application Information and Demo Board User Guide

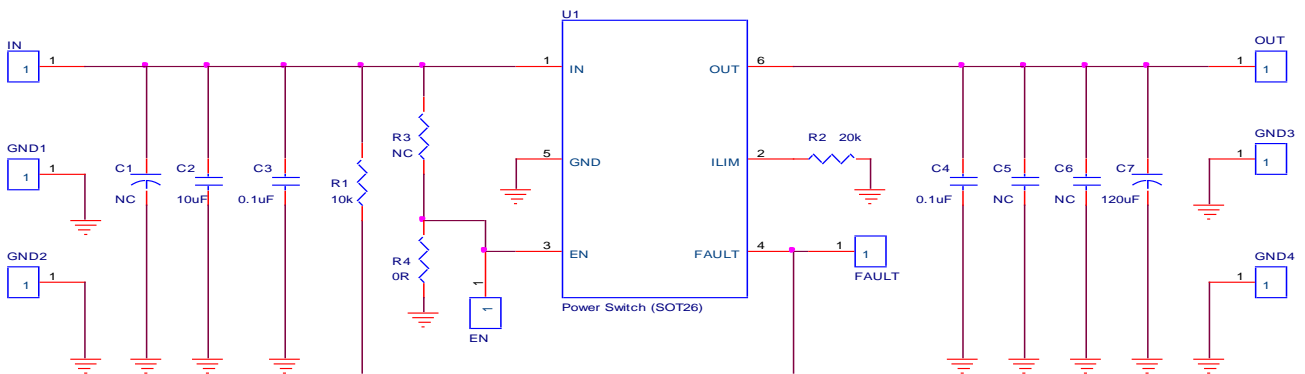
#### Quick Start Guide

The AP22652/53(Power Switch) evaluation modules (EVM) provide a means for the user to evaluate quickly the functionality and electrical performance of the AP22652/53 device. All inputs and outputs are brought out to test points for control and monitoring. All passive components are included on the EVM for device operation. The input pin should be connected to an external supply; the output should be connected to a load.

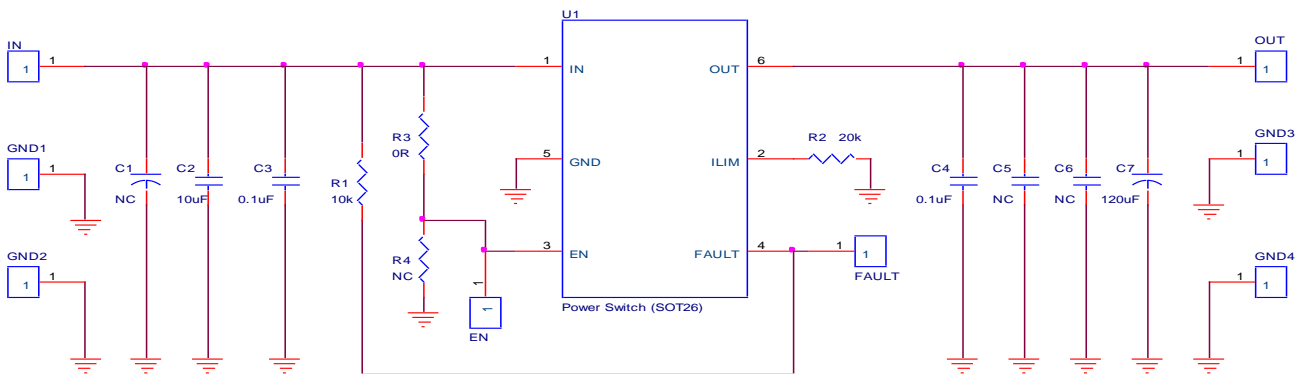
1. Connect a +5V power supply between IN and GND terminals.
2. Connect an adjustable current or resistive load to OUT and GND terminals.
3. Turn on the power supply.
4. Increase the load current of OUT and observe that the load current will stop increasing after reaching certain level. That is an indication that the device is limiting the load current.
5. Use an oscilloscope or a voltage meter to check that FAULT pin become low when the current limit is reached.

#### Evaluation Board Schematic

For AP22652W6



For AP22653W6



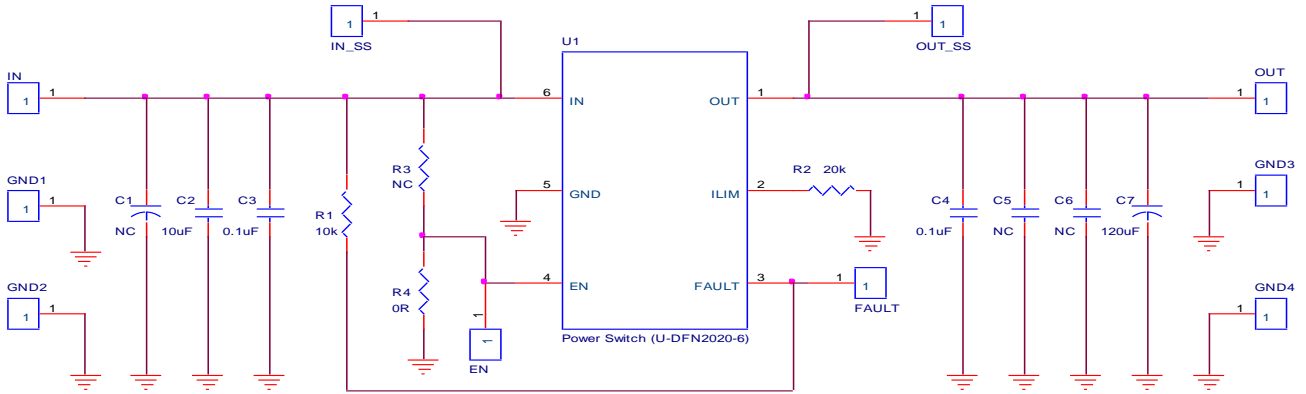
This application note contains new product information. Diodes, Inc. reserves the right to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sale of the product.

Application Note

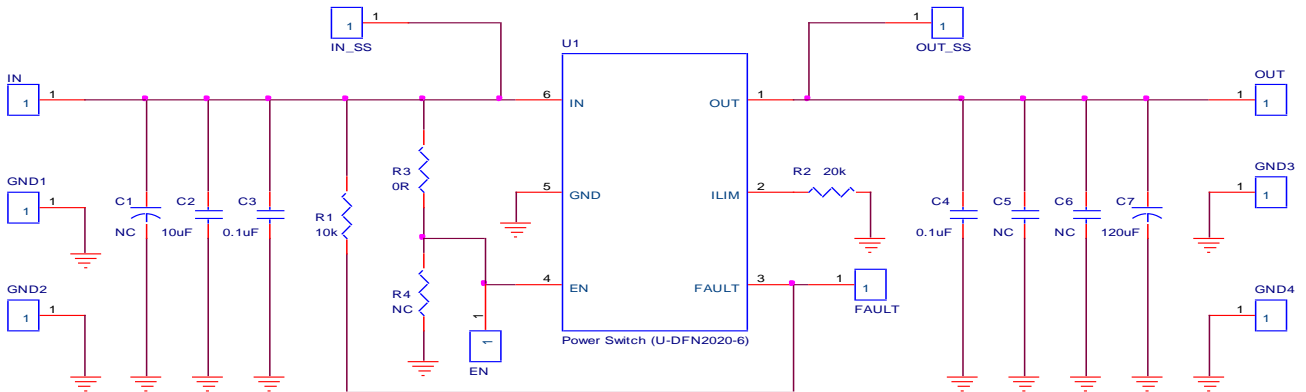
AP22652/53 Application Information and Demo Board User Guide

**Evaluation Board Schematic**

For AP22652FDZ



For AP22653FDZ



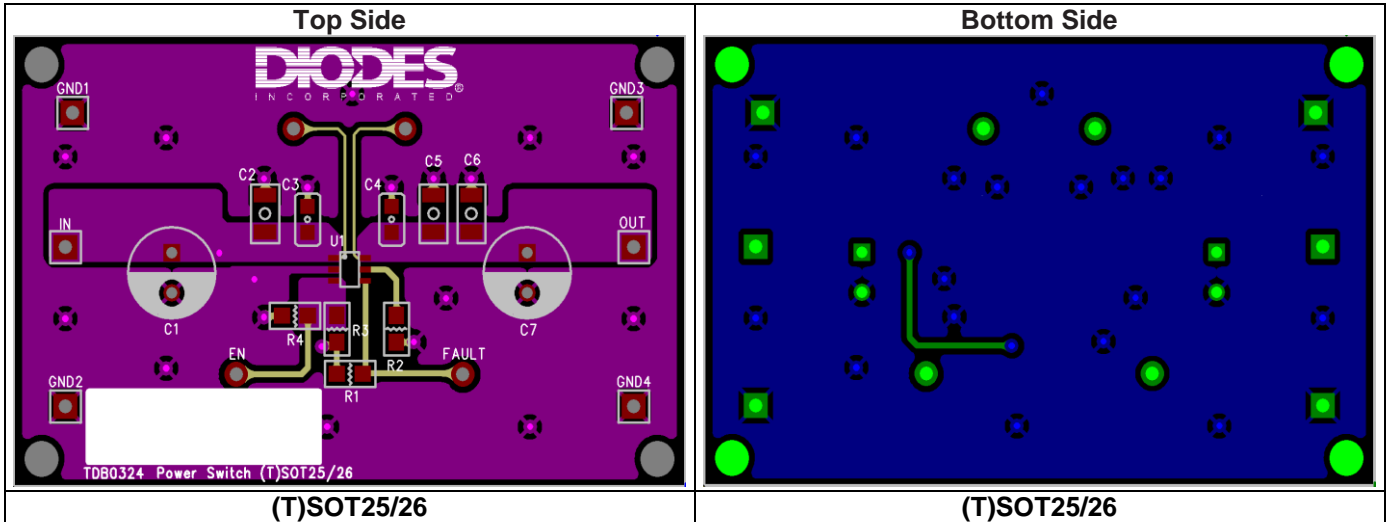
This application note contains new product information. Diodes, Inc. reserves the right to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sale of the product.

Application Note

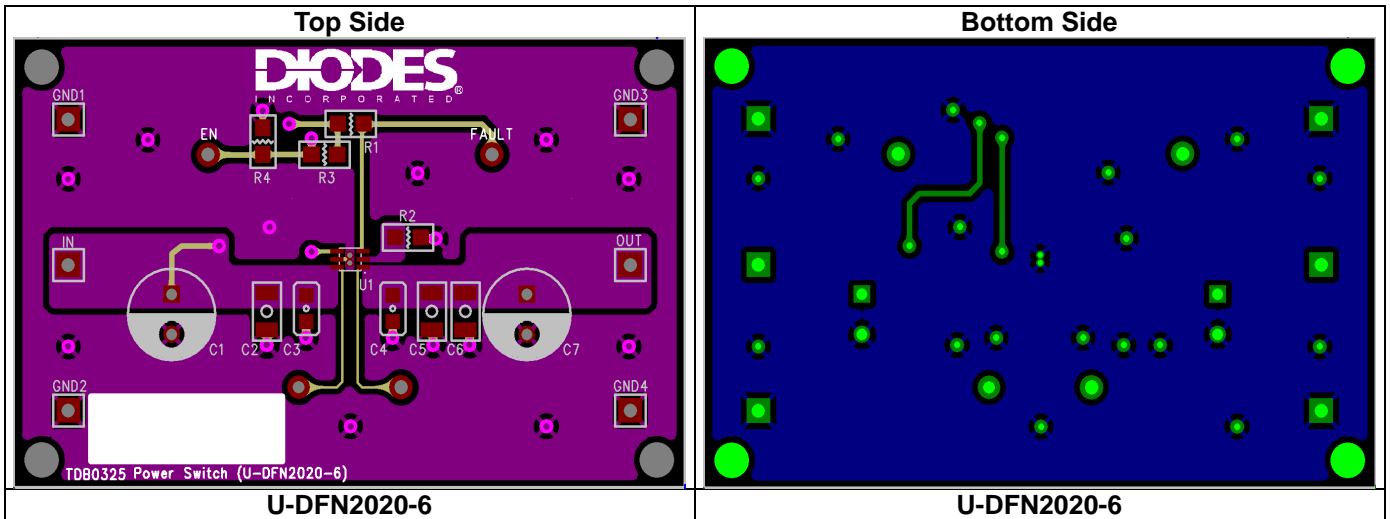
AP22652/53 Application Information and Demo Board User Guide

**PCB Layout**

For SOT26 Package



For W-DFN2020-6 Package



This application note contains new product information. Diodes, Inc. reserves the right to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sale of the product.

## Application Note

### AP22652/53 Application Information and Demo Board User Guide

#### Bill of Materials

##### For AP22652W6

Component Location	Qty	Specification	Mark	Maker Part No.	Size
C2	1	Cap MLCC 10 $\mu$ F/16V/X5R	TAIYO YUDEN	EMK212ABJ106KG-T	C0805
C3, C4	2	Cap MLCC 0.1 $\mu$ F/50V/X7R	TAIYO YUDEN	UMK212B7104KG-T	C0603
C7	1	Aluminum Capacitor, 120 $\mu$ F /25V/SJ105 $^{\circ}$ C	TEAPO	KSJ127M025S1A5G11K	8X11
R1	1	Res 10k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
R2	1	Res 20k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
IN, OUT, GND1, GND2, GND3, GND4	6	Test pin	-	TEST-8	2.2mmX 13.5mm
FAULT	1	Test Point, Miniature, Red	Keystone	5000	Testpoint
R3	0	NC	-	-	-
R4	1	Short	-	-	-
C1, C5, C6	0	NC	-	-	-
U1	1	Precision Adjustable Current-Limited Power Switches, Up to 2.1A, Active Low	Diodes Inc.	AP22652W6	SOT26
PCB	1	Power Switch (T)SOT25/26	Diodes Inc.	TDB0324	61mmX39mm

##### For AP22653W6

Component Location	Qty	Specification	Mark	Maker Part No.	Size
C2	1	Cap MLCC 10 $\mu$ F/16V/X5R	TAIYO YUDEN	EMK212ABJ106KG-T	C0805
C3, C4	2	Cap MLCC 0.1 $\mu$ F/50V/X7R	TAIYO YUDEN	UMK212B7104KG-T	C0603
C7	1	Aluminum Capacitor, 120 $\mu$ F /25V/SJ105 $^{\circ}$ C	TEAPO	KSJ127M025S1A5G11K	8X11
R1	1	Res 10k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
R2	1	Res 20k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
IN, OUT, GND1, GND2, GND3, GND4	6	Test pin	-	TEST-8	2.2mmX 13.5mm
FAULT	1	Test Point, Miniature, Red	Keystone	5000	Testpoint
R3	1	Short	-	-	-
R4	0	NC	-	-	-
C1, C5, C6	0	NC	-	-	-
U1	1	Precision Adjustable Current-Limited Power Switches, Up to 2.1A, Active High	Diodes Inc.	AP22653W6	SOT26
PCB	1	Power Switch (T)SOT25/26	Diodes Inc.	TDB0324	61mmX39mm

This application note contains new product information. Diodes, Inc. reserves the right to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sale of the product.



## Application Note

### AP22652/53 Application Information and Demo Board User Guide

#### Bill of Materials

##### For AP22652FDZ

Component Location	Qty	Specification	Mark	Maker Part No.	Size
C2	1	Cap MLCC 10 $\mu$ F/16V/X5R	TAIYO YUDEN	EMK212ABJ106KG-T	C0805
C3, C4	2	Cap MLCC 0.1 $\mu$ F/50V/X7R	TAIYO YUDEN	UMK212B7104KG-T	C0603
C7	1	Aluminum Capacitor, 120 $\mu$ F /25V/SJ105 $^{\circ}$ C	TEAPO	KSJ127M025S1A5G11K	8X11
R1	1	Res 10k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
R2	1	Res 20k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
IN, OUT, GND1, GND2, GND3, GND4,	6	Test pin	-	TEST-8	2.2mmX 13.5mm
FAULT	1	Test Point, Miniature, Red	Keystone	5000	Testpoint
R3	0	NC	-	-	-
R4	1	Short	-	-	-
C1, C5, C6	0	NC	-	-	-
U1	1	Precision Adjustable Current-Limited Power Switches, Up to 2.1A, Active Low	Diodes Inc.	AP22652FDZ	W-DFN2020-6
PCB	1	Power Switch (U-DFN2020-6)	Diodes Inc.	TDB0325	61mmX39mm

##### For AP22653FDZ

Component Location	Qty	Specification	Mark	Maker Part No.	Size
C2	1	Cap MLCC 10 $\mu$ F/16V/X5R	TAIYO YUDEN	EMK212ABJ106KG-T	C0805
C3, C4	2	Cap MLCC 0.1 $\mu$ F/50V/X7R	TAIYO YUDEN	UMK212B7104KG-T	C0603
C7	1	Aluminum Capacitor, 120 $\mu$ F /25V/SJ105 $^{\circ}$ C	TEAPO	KSJ127M025S1A5G11K	8X11
R1	1	Res 10k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
R2	1	Res 20k $\Omega$ (1%)	YAGEO	RC0603FR-SK	R0603
IN, OUT, GND1, GND2, GND3, GND4,	6	Test pin	-	TEST-8	2.2mmX 13.5mm
FAULT	1	Test Point, Miniature, Red	Keystone	5000	Testpoint
R3	1	Short	-	-	-
R4	0	NC	-	-	-
C1, C5, C6	0	NC	-	-	-
U1	1	Precision Adjustable Current-Limited Power Switches, Up to 2.1A, Active High	Diodes Inc.	AP22653FDZ	W-DFN2020-6
PCB	1	Power Switch (U-DFN2020-6)	Diodes Inc.	TDB0325	61mmX39mm

This application note contains new product information. Diodes, Inc. reserves the right to modify the product specification without notice. No liability is assumed as a result of the use of this product. No rights under any patent accompany the sale of the product.



## Application Note

### AP22652/53 Application Information and Demo Board User Guide

---

#### Vendors of peripheral components

##### Suggested Capacitors :

Vendor	Capacitance	Type	Series
TAIYO YUDEN	Cap MLCC 10 $\mu$ F/16V/X5R	SMD	EMK212ABJ106KG-T
MURATA	Cap MLCC 10 $\mu$ F/16V/X6S	SMD	GRM21BC81C106KA73L
TAIYO YUDEN	Cap MLCC 0.1 $\mu$ F/100V/X5R	SMD	HMK107BJ104KA-T
TAIYO YUDEN	Cap MLCC 0.1 $\mu$ F/50V/X7R	SMD	UMK212B7104KG-T
MURATA	Cap MLCC 0.1 $\mu$ F/16V/X7R	SMD	GRM033Z71C104KE14
TEAPO	Aluminum Capacitor, 120 $\mu$ F /25V/SJ105°C	DIP	KSJ127M025S1A5G11K

##### Suggested Resistor :

Vendor	Type	Series
YAGEO	SMD	RC0603FR-SK

## Application Note

### AP22652/53 Application Information and Demo Board User Guide

---

#### IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

#### LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the

failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2020, Diodes Incorporated

[www.diodes.com](http://www.diodes.com)