MASW-000834

HMIC™ PIN Diode SPDT 50 Watt Switch for 0.05 - 6.0 GHz Higher Power Applications

Rev. V9

Features

- Exceptional Broadband Performance
- Low Loss:
  T_X = 0.33 dB @ 2010 MHz, 5 V / 20 mA
  T_X = 0.38 dB @ 3.5 GHz, 5 V / 20 mA
- High Isolation:
  R_X = 44 dB @ 2010 MHz, 20 mA / 5 V
  R_X = 36 dB @ 3.5 GHz, 20 mA / 5 V
- High T_X RF Input Power:
  50 W CW @ 2010 MHz
- High T_X RF Input Peak Power:
  >1000 W
- Suitable for Very High Power TD-SCDMA & WiMAX Applications
- Surface Mount 4 mm PQFN Package
- RoHS* Compliant

Description and Applications

The MASW-000834-13560T is a SPDT broadband, high linearity, common anode, PIN diode T/R switch, for 0.05 - 6.0 GHz applications, including WiMAX & WiFi. The device is provided in industry standard 4 mm PQFN plastic packaging. This device incorporates a PIN diode die fabricated with MACOMs' patented silicon-glass HMIC™ process. This chip features two silicon pedestals embedded in a low loss, low dispersion glass. The diodes are formed on the top of each pedestal. The topside is fully encapsulated with silicon nitride and has an additional polymer passivation layer that prevents damage and contamination during handling and assembly.

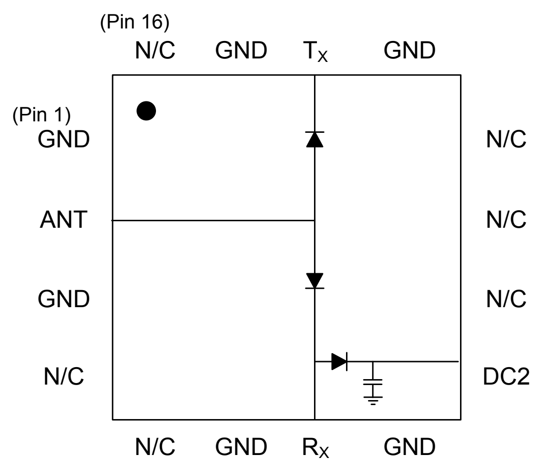
This compact SPDT switch offers wideband performance with excellent isolation to loss ratio for both T_X and R_X states. The PIN diode provides 50 W typical CW power handling and 65 dBm IIP3 at 2010 MHz for maximum switch performance.

Ordering Information

Part Number	Package
MASW-000834-13560T	1000 piece reel
MASW-000834-001SMB	Sample Board
MADR-008851-0001TB[1]	Sample Board

1. Sample board with recommended external driver & MASW-000834-13560T switch.

Functional Diagram (Top View)



Pin Configuration[2]

Pin	Function	Pin	Function
1	GND	9	DC2
2	ANT	10	N/C
3	GND	11	N/C
4	N/C	12	N/C
5	N/C	13	GND
6	GND	14	T_X
7	R_X	15	GND
8	GND	16	N/C

2. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

Electrical Specifications[3]:
T_A = +25°C, 20 mA / 5 V, P_{INC} = 0 dBm, Z_0 = 50 Ω

Parameter	Symbol	Units	Min.	Typ.	Max.
F = 900 MHz					
Insertion Loss, R_X	R_X IL	dB	—	0.34	0.56
Insertion Loss, T_X	T_X IL	dB	—	0.26	0.445
Isolation, ANT To R_X	R_X ISO	dB	45.8	52.1	—
Isolation, ANT To T_X	T_X ISO	dB	21.7	27.1	—
F = 1800 MHz					
Insertion Loss, R_X	R_X IL	dB	—	0.40	0.72
Insertion Loss, T_X	Tx IL	dB	—	0.32	0.49
Isolation, ANT To R_X	Rx ISO	dB	43.7	48.9	—
Isolation, ANT To T_X	T_X ISO	dB	18.4	21.4	—
F = 2010 MHz					
Insertion Loss, R_X	R_X IL	dB	—	0.42	0.75
Insertion Loss, T_X	T_X IL	dB	—	0.33	0.5
Isolation, ANT To R_X	R_X ISO	dB	43.2	44.6	—
Isolation, ANT To T_X	T_X ISO	dB	17.7	19.9	—
Input Return Loss, T_X	T_X RL	dB	—	32.1	—
Input Return Loss, R_X	R_X RL	dB	—	24.2	—

3. See Bias Table 1.

Electrical Specifications[3]:
T_A = +25°C, 20 mA / 5 V, P_{INC} = 0 dBm, Z_0 = 50 Ω

Parameter	Symbol	Units	Min.	Typ.	Max.
F = 2.3 - 2.7 GHz					
Insertion Loss, R_X	R_X IL	dB	—	0.46	0.84
Insertion Loss, T_X	T_X IL	dB	—	0.35	0.525
Isolation, ANT To R_X	R_X ISO	dB	40.2	41.2	—
Isolation, ANT To T_X	T_X ISO	dB	16.2	18.6	—
Input Return Loss, T_X	T_X RL	dB	—	30.5	—
Input Return Loss, R_X	R_X RL	dB	—	22.9	—
F = 3.3 - 3.8 GHz					
Insertion Loss, R_X	R_X IL	dB	—	0.56	1.0
Insertion Loss, T_X	T_X IL	dB	—	0.38	0.575
Isolation, ANT To R_X	R_X ISO	dB	33.7	35.9	—
Isolation, ANT To T_X	T_X ISO	dB	13.6	16.1	—
Input Return Loss, T_X	T_X RL	dB	—	27.4	—
Input Return Loss, R_X	R_X RL	dB	—	21.9	—
F = 4.9 - 5.9 GHz					
Insertion Loss, R_X	R_X IL	dB	—	0.78	—
Insertion Loss, T_X	T_X IL	dB	—	0.52	—
Isolation, ANT To R_X	R_X ISO	dB	—	26.4	—
Isolation, ANT To T_X	T_X ISO	dB	—	11.8	—
Input Return Loss, T_X	T_X RL	dB	—	20.3	—
Input Return Loss, R_X	R_X RL	dB	—	24.2	—

Electrical Specifications[4]:
T_A = +25°C, 50 mA / 25 V, P_{INC} = 0 dBm, Z_0 = 50 Ω

Parameter	Symbol	Units	Min.	Typ.	Max.
F = 900 MHz					
Insertion Loss, R_X	R_X IL	dB	—	0.27	—
Insertion Loss, T_X	T_X IL	dB	—	0.22	—
Isolation, ANT To R_X	R_X ISO	dB	—	53.3	—
Isolation, ANT To T_X	T_X ISO	dB	—	27.4	—
F = 1800 MHz					
Insertion Loss, R_X	R_X IL	dB	—	0.32	—
Insertion Loss, T_X	T_X IL	dB	—	0.27	—
Isolation, ANT To R_X	R_X ISO	dB	—	50.2	—
Isolation, ANT To T_X	T_X ISO	dB	—	21.6	—
F = 2010 MHz					
Insertion Loss, R_X	R_X IL	dB	—	0.34	—
Insertion Loss, T_X	T_X IL	dB	—	0.28	—
Isolation, ANT To R_X	R_X ISO	dB	—	45.5	—
Isolation, ANT To T_X	T_X ISO	dB	—	20.1	—
Input Return Loss, T_X	T_X RL	dB	—	33.1	—
Input Return Loss, R_X	R_X RL	dB	—	24.1	—

4. See Bias Table 2.

Electrical Specifications[4]: T_A = +25°C, 50 mA / 25 V, P_{INC} = 0 dBm, Z_0 = 50 Ω

Parameter	Symbol	Units	Min.	Typ.	Max.
F = 2.3 - 2.7 GHz					
Insertion Loss, R_X	R_X IL	dB	—	0.38	—
Insertion Loss, T_X	T_X IL	dB	—	0.30	—
Isolation, ANT To R_X	R_X ISO	dB	—	41.8	—
Isolation, ANT To T_X	T_X ISO	dB	—	18.7	—
Input Return Loss, T_X	T_X RL	dB	—	31.3	—
Input Return Loss, R_X	R_X RL	dB	—	22.8	—
F = 3.3 - 3.8 GHz					
Insertion Loss, R_X	R_X IL	dB	—	0.47	—
Insertion Loss, T_X	T_X IL	dB	—	0.33	—
Isolation, ANT To R_X	R_X ISO	dB	—	36.2	—
Isolation, ANT To T_X	T_X ISO	dB	—	16.2	—
Input Return Loss, T_X	T_X RL	dB	—	28.0	—
Input Return Loss, R_X	R_X RL	dB	—	21.8	—
F = 4.9 - 5.9 GHz					
Insertion Loss, R_X	R_X IL	dB	—	0.72	—
Insertion Loss, T_X	T_X IL	dB	—	0.48	—
Isolation, ANT To R_X	R_X ISO	dB	—	26.6	—
Isolation, ANT To T_X	T_X ISO	dB	—	11.8	—
Input Return Loss, T_X	T_X RL	dB	—	20.5	—
Input Return Loss, R_X	R_X RL	dB	—	24.2	—

Electrical Specifications:
T_A = +25°C, 50 mA / 25 V, Z_0 = 50 Ω

Parameter	Symbol	Test Conditions	Units	Min.	Typ.	Max.
T_X Input P1dB	T_X P1dB	2010 MHz, T_X to Antenna 3.5 GHz, T_X to Antenna	dBm	—	>45.5 >45.0	—
T_X 2nd Harmonic	T_X 2Fo	2010 MHz, P_{IN} = +30 dBm 3.5 GHz, P_{IN} = +30 dBm	dBc	—	80 88	—
T_X 3rd Harmonic	T_X 3Fo	2010 MHz, P_{IN} = +30 dBm 3.5 GHz, P_{IN} = +30 dBm	dBc	—	95 105	—
T_X Input IP3	T_X IIP3	P_{IN} = +10 dBm, F1 = 2010 MHz, F2 = 2020 MHz P_{IN} = +10 dBm, F1 = 3.50 GHz, F2 = 3.51 GHz	dBm	—	>64 >64	—
T_X CW Input Power	T_X P_{INC}	F = 2010 MHz	dBm / W	—	47 / 50	—
R_X CW Input Power	R_X P_{INC}	F = 2010 MHz F = 3.5 GHz	dBm / W	—	41.5 / 14 40.5 / 11	—
T_X RF Switching Speed	t_{RF}	F = 2010 MHz (10-90% RF Voltage) F = 3.5 GHz (10-90% RF Voltage) 1 MHz Rep Rate in Modulating Mode	ns	—	200 200	—

Absolute Maximum Ratings[5,6]
@ T_A = +25°C (unless otherwise specified)

Parameter	Absolute Maximum
Forward Current	| 100 mA |
RF & DC Reverse Voltage	| -200 V |
T_X Incident CW Power	50 W (47 dBm)[7] @ 2010 MHz
T_X Peak Incident Power	>300 W, 5 µs, 1% duty
Junction Temperature	+175°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +150°C

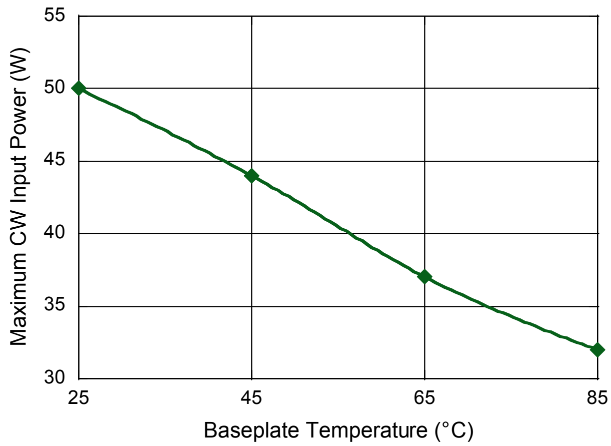
5. Exceeding these limits may cause permanent damage.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Baseplate Temperature must be controlled to a constant +25°C. See derating curve.

Static Sensitivity

These devices are rated Class 1B Human Body. Proper ESD control techniques should be used when handling these devices.

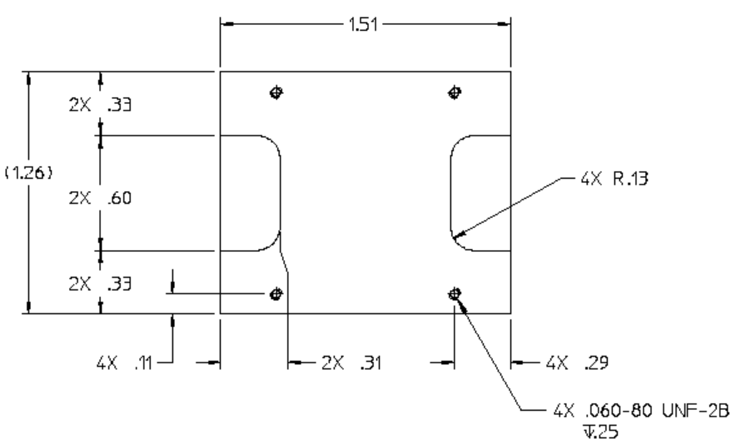
Typical Power Derating Curve

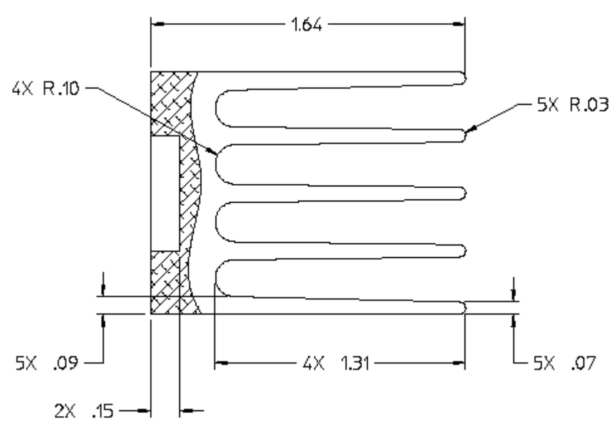
T_X Maximum CW Input Power
(50 mA Forward Bias, 2010 MHz)



Note that this part must be held to a constant baseplate temperature to achieve the power handling results specified above. Adding a heatsink to the baseplate will improve performance to values greater than shown here. The increase in maximum input power from using a heatsink depends on the specific heatsink design.

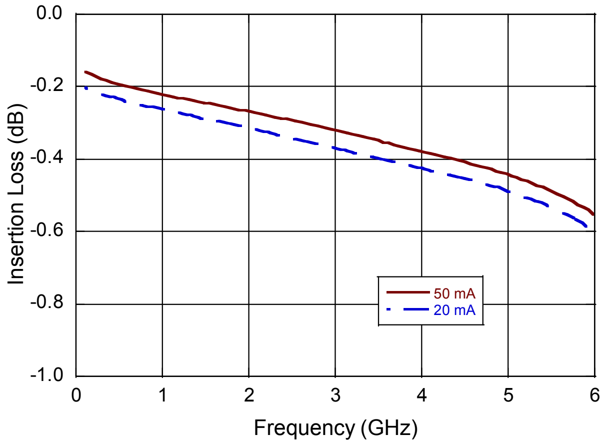
With a sample board mounted onto a heatsink of dimensions and fins shown below, this switch can handle up to 35 W CW of incident power.



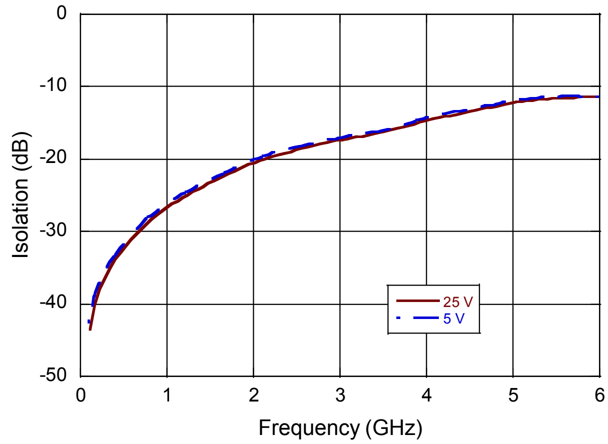


T_X Performance Curves @ +25°C, Z_0 = 50 Ω

T_X Insertion Loss, 20 mA & 50 mA

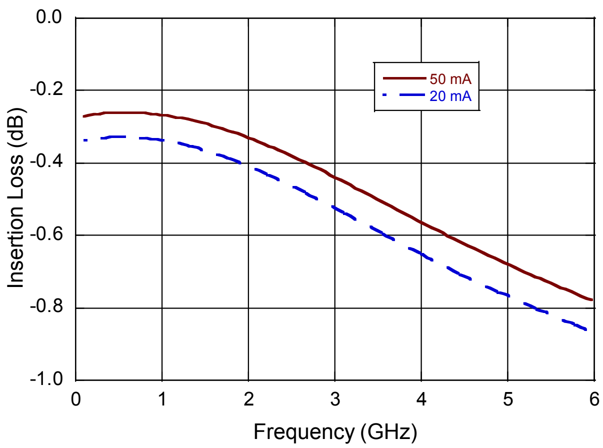


T_X Isolation, 5 V & 25 V

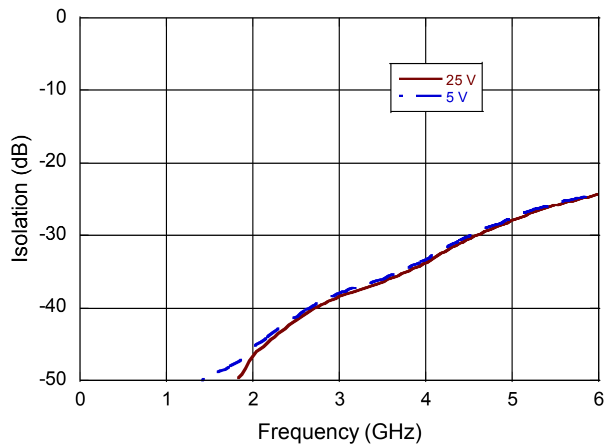


R_X Performance Curves @ +25°C, Z_0 = 50 Ω

R_X Insertion Loss, 20 mA & 50 mA

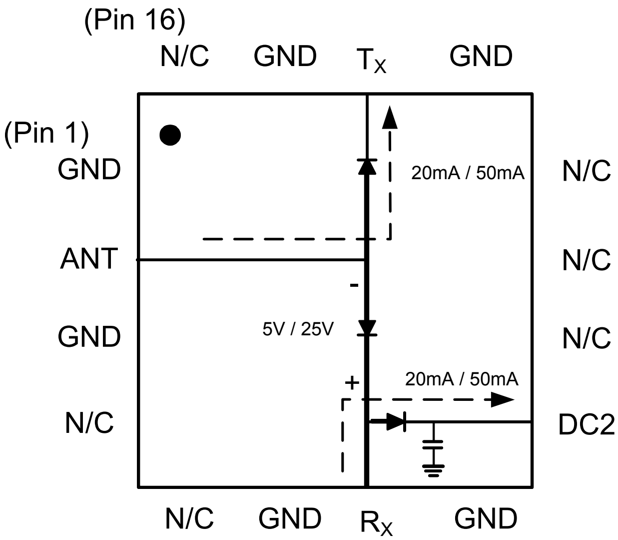


R_X Isolation, 5 V & 25 V

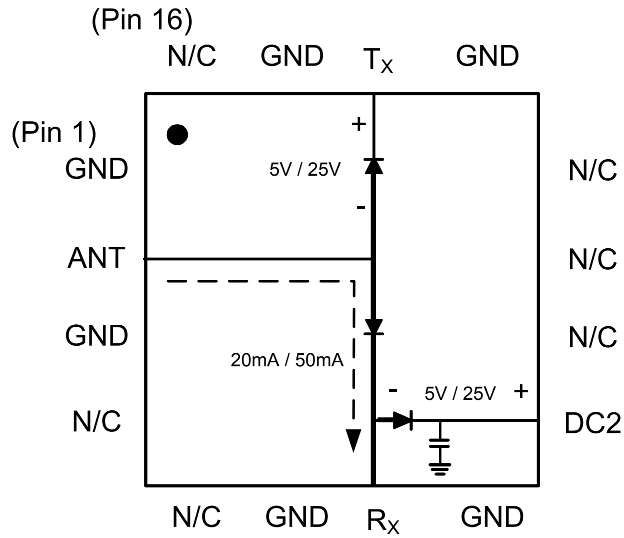


Bias Diagrams & Tables[8]

T_X-ANT Insertion Loss, R_X-ANT Isolation



R_X-ANT Insertion Loss, T_X-ANT Isolation



Bias Table 1

Parameter	T_X	R_X	DC2	ANT
	Pin 14	Pin 7	Pin 9	Pin 2
T_X-ANT Insertion Loss R_X-ANT Isolation	-20 mA	+5 V, +20 mA	-20 mA	0 V, +20 mA
R_X-ANT Insertion Loss T_X-ANT Isolation	+5 V, 0 mA	-20 mA	+5 V, 0 mA	0 V, +20 mA

Bias Table 2

Parameter	T_X	R_X	DC2	ANT
	Pin 14	Pin 7	Pin 9	Pin 2
T_X-ANT Insertion Loss R_X-ANT Isolation	-50 mA	+25 V, +50 mA	-50 mA	0 V, +50 mA
R_X-ANT Insertion Loss T_X-ANT Isolation	+25 V, 0 mA	-50 mA	+25 V, 0 mA	0 V, +50 mA

8. Diode Based Products require different minimum reverse bias voltages depending on the frequency and incident power levels. More details can be found on page 10 of this datasheet.

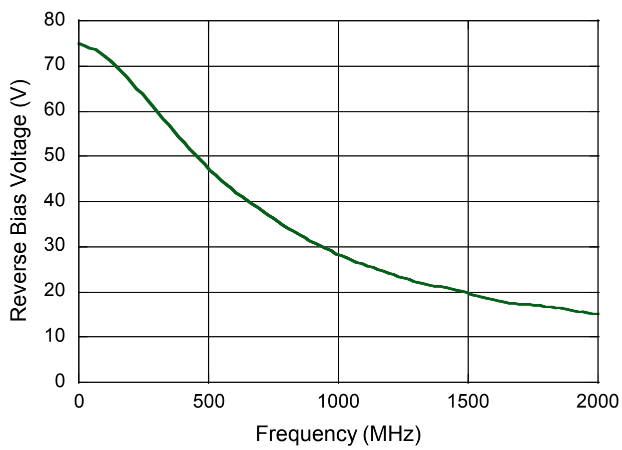
Minimum Required Reverse Bias Voltage

Minimum reverse bias voltage on a PIN diode based product varies with frequency of operation and incident power levels. As a rule of thumb, a designer can always use the magnitude of the peak RF voltage or empirically locate lower bias values than the peak RF voltage magnitude. However, it has been shown that lower DC voltages can be used depending on the RF environment in which a diode is placed. In the plot below, the minimum required reverse voltage vs. frequency is shown for an incident RF power of 50 Watts. This trend line will shift lower if the incident RF power is decreased. The biasing values have not been verified through measurement at MACOM. As a result, please use the data below as a guide only for biasing requirements as this data is based solely on generic PIN diode equations.[9]

Please be cautious in that lower reverse bias levels can degrade isolation and distortion in a PIN diode based product.

9. R. Caverly and G. Hiller, "Establishing the Minimum Reverse Bias for a P-I-N Diode in a High Power Switch," IEEE Transactions on Microwave Theory and Techniques, Vol.38, No.12, December 1990.

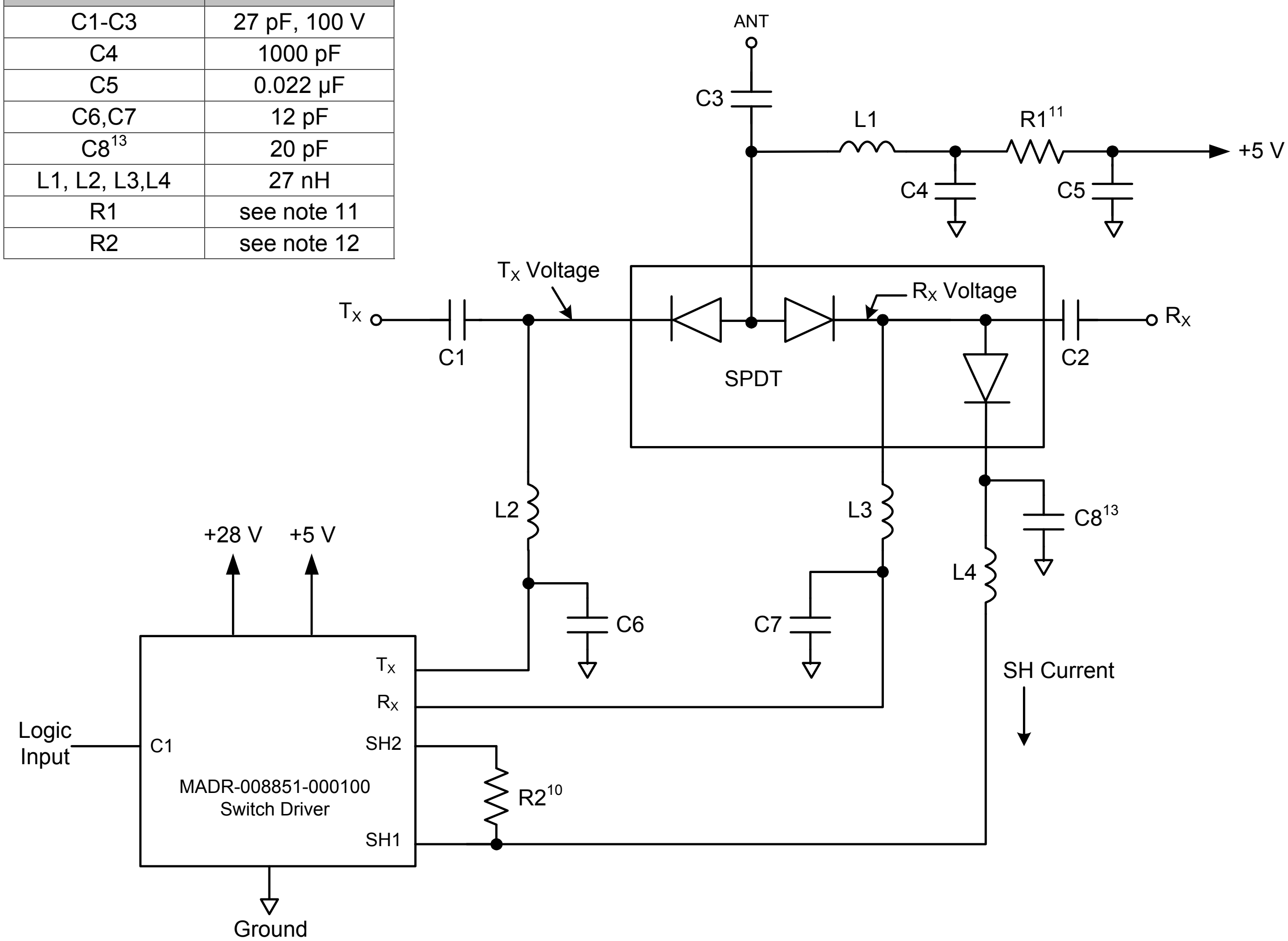
Reverse Bias Required vs. Frequency (50 W Power Handling)



MASW-000834 and Recommended Driver with +5 V & +28 V DC Power[10,11,12,13,14,15,16,17]

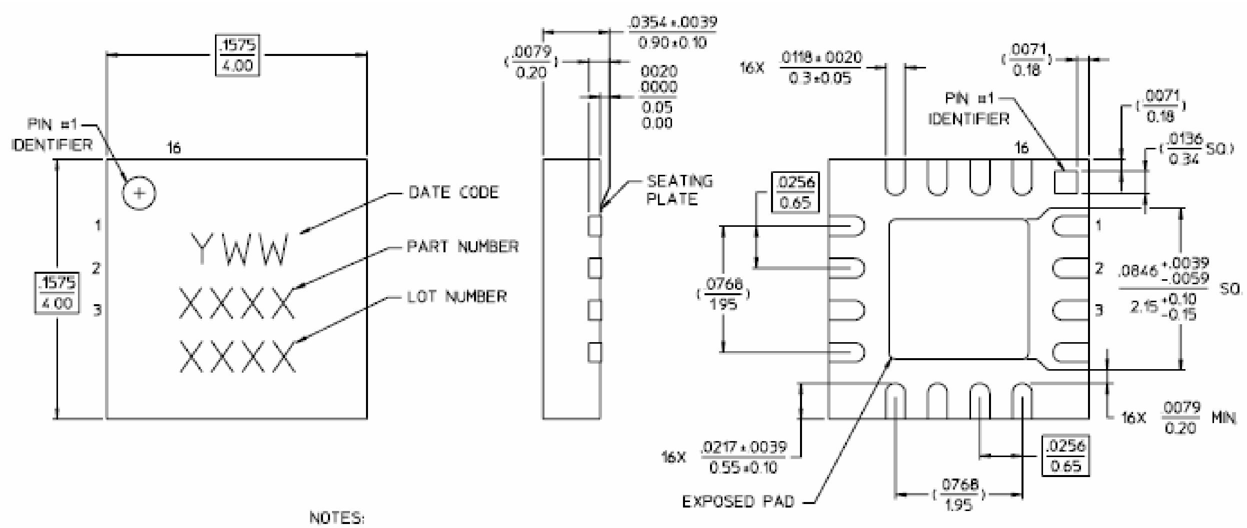
MADR-008851 is the recommended driver for the MASW-000834 Switch.

Part	Value
C1-C3	27 pF, 100 V
C4	1000 pF
C5	0.022 µF
C6,C7	12 pF
C8[13]	20 pF
L1, L2, L3,L4	27 nH
R1	see note 11
R2	see note 12



10. Forward Bias Diode Voltage: DV_F is ~0.9 V @ 22 mA; DV_F is ~1.0 V @ 35 mA
11. R1 is calculated by (V_{CC} - 1.5 V)/I_{SERIES}, where I_{SERIES} is the desired bias current for the series diodes:
    For 21 mA load current, R1 = 165 Ω @ V_{CC} = 5.0 V and 82 Ω @ V_{CC} = 3.3 V.
    For 32 mA load current, R1 = 110 Ω @ V_{CC} = 5.0 V and 56 Ω @ V_{CC} = 3.3 V.
12. R2 is calculated by (V_{DD} - 1.0 V)/I_{SHUNT}, where I_{SHUNT} is the desired forward bias current for the shunt diode. The power dissipation is calculated by I_{SHUNT} x 27 V. For 20 mA of I_{SHUNT}, R2 should use a 2511, 1W, 1.3k Ω resistor.
13. C8 is already built-in for MASW-000834-13560T switch.
14. The voltage at the common anode will be approximately 1.5 V.
15. The current in through the back-biased diodes will be the leakage current for the diodes.
16. C1-C5, L1-L4, R1, R2, and the switch are discrete components that should be installed on the users board. It is recommended that Coilcraft 0603CS-27NXJLW or equivalent be used for L1-L4 at 2 GHz (values may vary based on the frequency).
17. There are 33 pF bypass capacitors included in the driver for the R_X, T_X, and SH1 ports. There are cases (especially at higher frequencies), where the optional 12 pF bypass capacitors (C6 and C7) that are shown on the schematic are needed.

Outline: 4 mm PQFN 16-Lead Saw Singulated



NOTES:

1. REFERENCE JEDEC MO-220, VAR. VGGC FOR ADDITIONAL DIMENSIONAL AND TOLERANCE INFORMATION.
2. REFERENCE S2083 APPLICATION NOTE FOR PCB FOOTPRINT INFORMATION.
3. ALL DIMENSIONS SHOWN AS INCHES/MM.

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.