

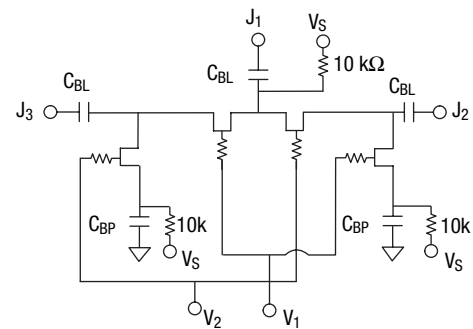
APPLICATION NOTE

APN2017: Positive Voltage Operation of GaAs Control ICs

Depletion mode GaAs IC control products that are not internally bypassed can be “floated” or “level shifted” to operate using 0/+3 to +5 V control voltages. This is a great advantage since the majority of high volume wireless designs have only a positive voltage supply available.

Switches

GaAs IC switches can easily be made to operate from a positive voltage supply (V_S) by “floating” the source/drain to the V_S voltage and controlling the gates with 0 and V_S voltages. This satisfies the requirement that the gate must be negative with respect to source/drain. Typical schematics implementing this technique are shown in Figures 1 and 2 for a series/shunt FET switch design. It is essential that the PCB ground plane be a minimal distance from the switch ground pins. The C_{BP} capacitor can then be soldered directly to ground minimizing the inductive path and maximizing the switch performance. (See Figure 2.)



$C_{BL} = 100 \text{ pF @ } 900 \text{ MHz}$
 $C_{BP} = .001 \text{ to } 0.1 \text{ }\mu\text{F depending on lowest operating frequency.}$

Truth Table

Negative Operation ($V_S = \text{Open}$)

| V_1 | V_2 | J_1-J_2 | J_1-J_3 |
|-------|-------|----------------|----------------|
| 0 | -5 | Isolation | Insertion loss |
| -5 | 0 | Insertion loss | Isolation |

Positive Operation ($V_S = 5 \text{ V}$)

| V_1 | V_2 | J_1-J_2 | J_1-J_3 |
|-------|-------|----------------|----------------|
| +5 | 0 | Isolation | Insertion loss |
| 0 | +5 | Insertion loss | Isolation |

Figure 1. Schematic Diagram and Truth Table for SPDT Series/Shunt Switch (AS239-12)

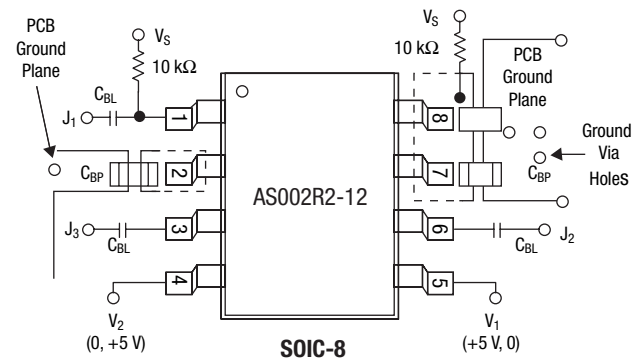
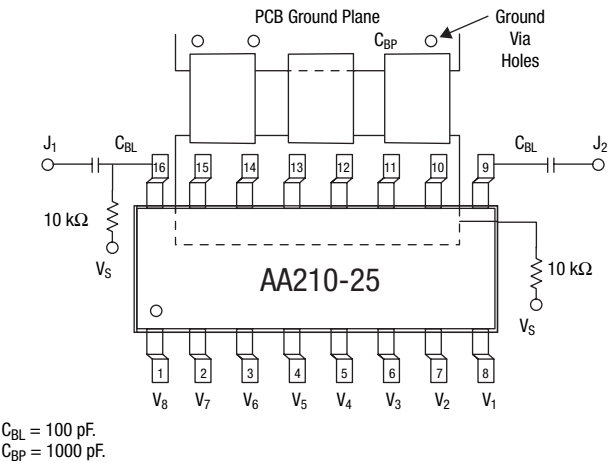


Figure 2. Positive Voltage Control Configuration

Digital Attenuators (DA) and Voltage Variable Attenuators (VVA)

The floating technique discussed for switches can be applied to other GaAs IC control devices. DAs utilize the same floating scheme to achieve positive voltage operation. The AA210-25 is shown as an example of a digital attenuator that is floated. (See Figure 3.) All ground pins are AC coupled to the PCB ground through a single bypass capacitor. Inductance to ground must be minimized to achieve the best possible RF performance of the device.



Truth Table

Positive Operation ($V_S = 5 \text{ V}$)

| V_1 | V_2 | V_3 | V_4 | V_5 | V_6 | V_7 | V_8 | Attenuation (dB) |
|-------|-------|-------|-------|-------|-------|-------|-------|------------------|
| 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 | Reference |
| 5 | 0 | 0 | 5 | 0 | 5 | 0 | 5 | 1 dB |
| 0 | 5 | 5 | 0 | 0 | 5 | 0 | 5 | 2 dB |
| 0 | 5 | 0 | 5 | 5 | 0 | 0 | 5 | 4 dB |
| 0 | 5 | 0 | 5 | 0 | 5 | 5 | 0 | 8 dB |
| 5 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 15 dB |

Figure 3. Positive Voltage Configuration of AA210-25 and Truth Table

Copyright © 2002, 2003, 2004, 2005, Skyworks Solutions, Inc. All Rights Reserved.

Information in this document is provided in connection with Skyworks Solutions, Inc. ("Skyworks") products or services. These materials, including the information contained herein, are provided by Skyworks as a service to its customers and may be used for informational purposes only by the customer. Skyworks assumes no responsibility for errors or omissions in these materials or the information contained herein. Skyworks may change its documentation, products, services, specifications or product descriptions at any time, without notice. Skyworks makes no commitment to update the materials or information and shall have no responsibility whatsoever for conflicts, incompatibilities, or other difficulties arising from any future changes.

No license, whether express, implied, by estoppel or otherwise, is granted to any intellectual property rights by this document. Skyworks assumes no liability for any materials, products or information provided hereunder, including the sale, distribution, reproduction or use of Skyworks products, information or materials, except as may be provided in Skyworks Terms and Conditions of Sale.

THE MATERIALS, PRODUCTS AND INFORMATION ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR USE, MERCHANTABILITY, PERFORMANCE, QUALITY OR NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHT; ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. SKYWORKS DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. SKYWORKS SHALL NOT BE LIABLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO ANY SPECIAL, INDIRECT, INCIDENTAL, STATUTORY, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS THAT MAY RESULT FROM THE USE OF THE MATERIALS OR INFORMATION, WHETHER OR NOT THE RECIPIENT OF MATERIALS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Skyworks products are not intended for use in medical, lifesaving or life-sustaining applications, or other equipment in which the failure of the Skyworks products could lead to personal injury, death, physical or environmental damage. Skyworks customers using or selling Skyworks products for use in such applications do so at their own risk and agree to fully indemnify Skyworks for any damages resulting from such improper use or sale.

Customers are responsible for their products and applications using Skyworks products, which may deviate from published specifications as a result of design defects, errors, or operation of products outside of published parameters or design specifications. Customers should include design and operating safeguards to minimize these and other risks. Skyworks assumes no liability for applications assistance, customer product design, or damage to any equipment resulting from the use of Skyworks products outside of stated published specifications or parameters.

Skyworks, the Skyworks symbol, and "Breakthrough Simplicity" are trademarks or registered trademarks of Skyworks Solutions, Inc., in the United States and other countries. Third-party brands and names are for identification purposes only, and are the property of their respective owners. Additional information, including relevant terms and conditions, posted at www.skyworksin.com, are incorporated by reference.