

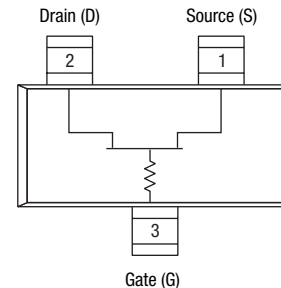
DATA SHEET

# AF002C1-39, AF002C1-39LF, AF002C4-39, AF002C4-39LF: GaAs IC Control FET Series 300 kHz–2.5 GHz

## Features

- Low-cost SOT-23 package
- Series or shunt configuration
- Low DC current drain
- Ideal switch building blocks
- Pin diode replacements
- High-power antenna switches
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 250 °C per JEDEC J-STD-020

## Pin Out



## Description

This group of GaAs control FETs can be used in both series and shunt configurations. They incorporate on-chip circuitry that eliminates the need for extra bias components and minimizes power drain to typically 25  $\mu$ W. These features make the devices ideal replacements for PIN diodes, where low DC drain is critical. Isolation performance degrades at higher frequencies due to package parasitics. They can be tuned out in narrow band applications as shown in the circuit examples on the following pages.

**NEW** Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.



## Electrical Specifications at 25 °C (0, -5 V)

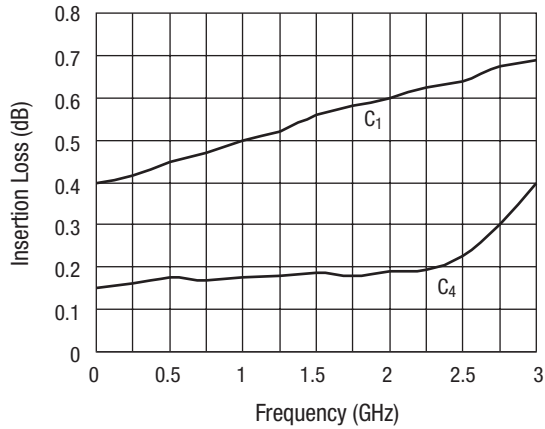
| Part Number <sup>(1)</sup> | Frequency (GHz) | R <sub>ON</sub> ( $\Omega$ ) <sup>(2)</sup> |      | Insertion Loss (dB) <sup>(3, 4)</sup> |       | C <sub>OFF</sub> (pF) <sup>(5)</sup> |      | Isolation (dB) <sup>(4)</sup> |       | P <sub>-1 dB</sub> (W) |
|----------------------------|-----------------|---|------|---------------------------------------|-------|--------------------------------------|------|-------------------------------|-------|------------------------|
|                            |                 | Typ.  | Max. | Series                                | Shunt | Typ.                                 | Max. | Series                        | Shunt |                        |
| AF002C1-39                 | 300 kHz–0.5 GHz | 6.4   | 9    | 0.5                                   | 0.1   | 0.13                                 | 0.25 | 25                            | 12    | 0.5                    |
|                            | 300 kHz–1.0 GHz | 6.4   | 9    | 0.6                                   | 0.15  | 0.13                                 | 0.25 | 17                            | 8     | 1                      |
|                            | 300 kHz–2.5 GHz | 6.4   | 9    | 0.7                                   | 0.2   | 0.13                                 | 0.25 | 13                            | 3     | 1                      |
| AF002C4-39                 | 300 kHz–0.5 GHz | 0.8   | 1.1  | 0.2                                   | 0.15  | 1.1                                  | 1.5  | 11                            | 15    | 6                      |
|                            | 300 kHz–1.0 GHz | 0.8   | 1.1  | 0.25                                  | 0.25  | 1.1                                  | 1.5  | 6                             | 9     | 7                      |
|                            | 300 kHz–2.5 GHz | 0.8   | 1.1  | 0.3                                   | 2     | 1.1                                  | 1.5  | 3                             | 4     | 7                      |

1. All measurements made in a 50  $\Omega$  system, unless otherwise specified.
2. R<sub>ON</sub> - resistance in  $\Omega$  in low impedance state when "0" V is applied to gate (G).
3. Insertion loss changes by 0.003 dB/°C.
4. Insertion loss and isolation typical values.
5. C<sub>OFF</sub> - capacitance (pF) in high impedance state when -5 V is applied to gate (G).

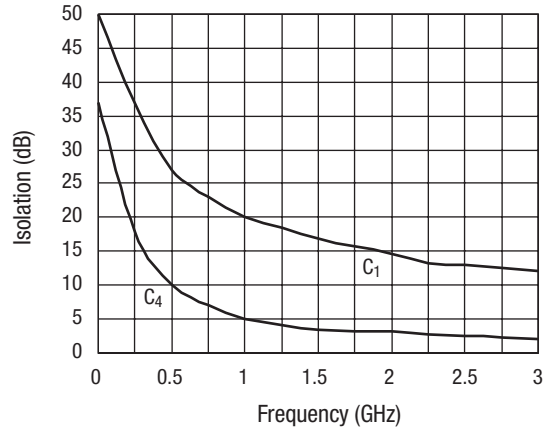
### Operating Characteristics at 25 °C (0, -5 V)

| Parameter                 | Condition  | Frequency | Min. | Typ. | Max. | Unit |
|---------------------------|--|-----------|------|------|------|------|
| Switching characteristics |  |           |      |      |      |      |
| Rise, fall                | 10/90% or 90/10% RF  |           |      | 6    |      | ns   |
| On, off                   | 50% CTL to 90/10% RF   |           |      | 12   |      | ns   |
| Thermal resistance        |  |           |      | 25   |      | °C/W |
| Control voltages          | $V_{LOW} = 0$ to $-0.2$ V @ 20 $\mu$ A max.<br>$V_{HIGH} = -5$ V @ 50 $\mu$ A to $-9$ V @ 200 $\mu$ A max. |           |      |      |      |      |

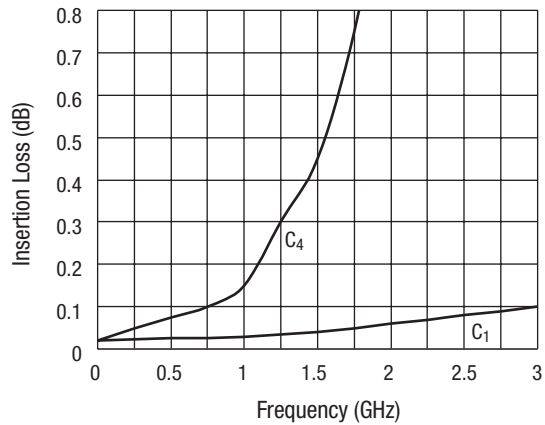
### Typical Performance Data (0, -5 V)



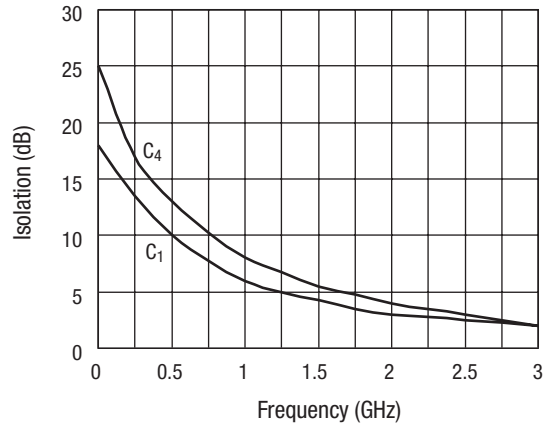
**Insertion Loss vs. Frequency  
Series Configuration**



**Isolation vs. Frequency  
Series Configuration**



**Insertion Loss vs. Frequency  
Shunt Configuration**



**Isolation vs. Frequency  
Shunt Configuration**

## Absolute Maximum Ratings

### AF002C1-39

| Characteristic        | Value   |
|-----------------------|---|
| RF input power        | 2 W > 500 MHz 0/-8 V<br>0.5 W @ 50 MHz 0/-8 V |
| Control voltage       | +0.2 V, -10 V                                 |
| Operating temperature | -40 °C to +85 °C                              |
| Storage temperature   | -65 °C to +150 °C                             |

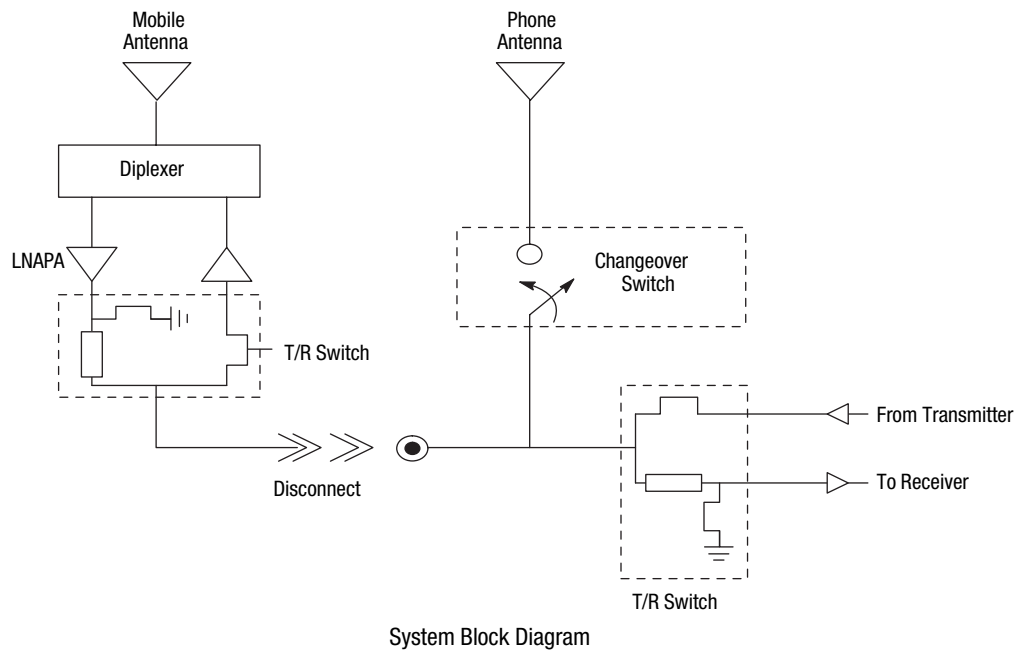
### AF002C4-39

| Characteristic        | Value                  |
|-----------------------|------------------------|
| RF input power        | 8 W > 450 MHz, 0/-12 V |
| Control voltage       | +0.2, -12 V            |
| Operating temperature | -40 °C to +85 °C       |
| Storage temperature   | -65 °C to +150 °C      |

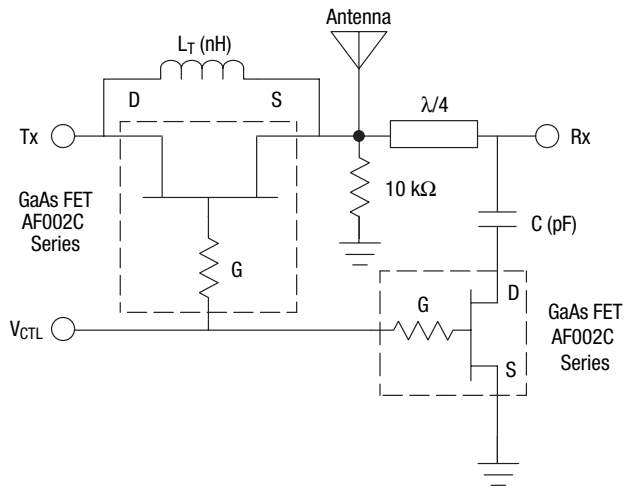
Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

**CAUTION:** Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.

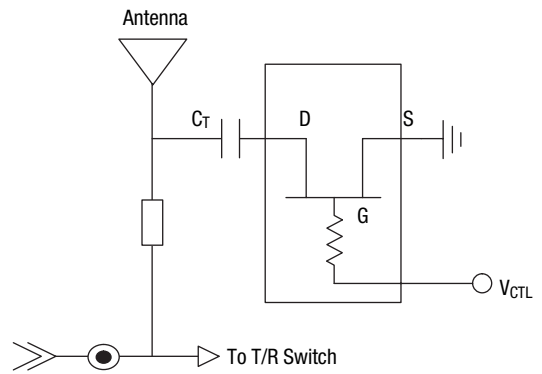
## T/R and Antenna Changeover Switch for Mobile Cellular Systems



### T/R Switch Schematic



### Changeover Switch Schematic



### Truth Table for T/R Switch

| V <sub>CTL</sub> (V) | Tx to Antenna  | Rx to Antenna  |
|----------------------|----------------|----------------|
| 0                    | Low loss       | High isolation |
| -5                   | High isolation | Low loss       |

See next page for positive voltage operation.

### Truth Table for Changeover Switch

| V <sub>CTL</sub> (V) | Antenna   |
|----------------------|-----------|
| -5                   | Connected |
| 0                    | Isolated  |

See next page for positive voltage operation.

### Component Values for T/R Switch Circuit

| Part Number | L <sub>T</sub> (nH) | C <sub>T</sub> (pF) | Freq. (GHz) |
|-------------|---------------------|---------------------|-------------|
| AF002C1-39  | 165                 | 18.8                | 0.45        |
| AF002C4-39  | 85                  | 18.8                | 0.45        |
| AF002C1-39  | 44                  | 4.7                 | 0.9         |
| AF002C4-39  | 22                  | 4.7                 | 0.9         |

**Truth Table**

**Negative Voltage Operation**

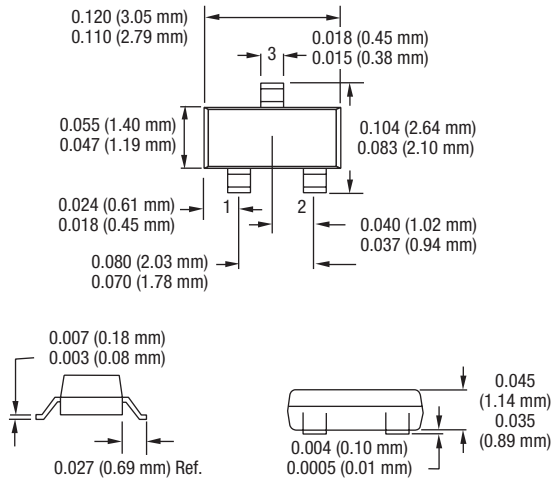
| S             | D  | G  | RF Path        |
|---------------|----|----|----------------|
| <b>Shunt</b>  |    |    |                |
| GND           | RF | -5 | Insertion loss |
|               |    | 0  | Isolation      |
| <b>Series</b> |    |    |                |
| RF            | RF | 0  | Insertion loss |
|               |    | -5 | Isolation      |

**Positive Voltage Operation**

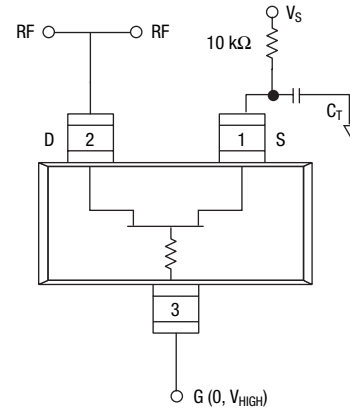
| S             | D  | G                 | RF Path        |
|---------------|----|-------------------|----------------|
| <b>Shunt</b>  |    |                   |                |
| GND           | RF | 0                 | Insertion loss |
|               |    | V <sub>HIGH</sub> | Isolation      |
| <b>Series</b> |    |                   |                |
| RF            | RF | 0                 | Isolation      |
|               |    | V <sub>HIGH</sub> | Insertion loss |

V<sub>HIGH</sub> = +5 to +9 V (V<sub>S</sub> = V<sub>HIGH</sub> ± 0.2 V).

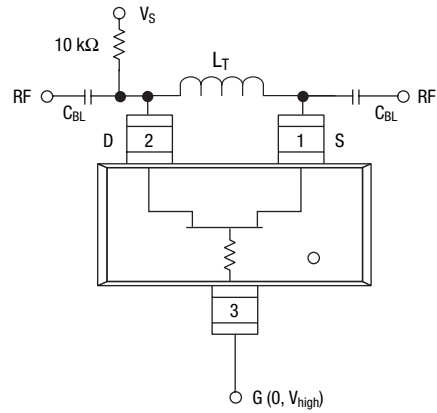
**SOT-23**



**Positive Voltage Operation**



**Shunt Configuration**



**Series Configuration**

C<sub>BL</sub> - Chose value for lowest impedance at desired operating frequency.

**Recommended Solder Reflow Profiles**

Refer to the [“Recommended Solder Reflow Profile”](#) Application Note.

**Tape and Reel Information**

Refer to the [“Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation”](#) Application Note.

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