

# VFM Step-Up DC/DC Converter

## General Description

The RT9261 Series are VFM Step-up DC/DC ICs with ultra low supply current by CMOS process and suitable for use with battery-powered instruments.

The RT9261 IC consists of an oscillator, a VFM control circuit, a driver transistor (LX switch), a reference voltage unit, an error amplifier, resistors for voltage detection, and a LX switch protection circuit. A low ripple and high efficiency step-up DC/DC converter can be constructed of this RT9261 IC with only three external components.

The RT9261A IC provides with a drive pin (EXT) for an external transistor, so that a power transistor can be externally applied. Therefore, the RT9261A IC is recommended for applications where large currents are required. EN pin enables circuit to set the standby supply current at a maximum of 0.5 $\mu$ A.

## Ordering Information

|                                      |  |
|--------------------------------------|--|
| RT9261/A-□□□□                        |  |
| Package Type                         |  |
| B : SOT-23-5                         |  |
| X : SOT-89                           |  |
| Lead Plating System                  |  |
| P : Pb Free                          |  |
| G : Green (Halogen Free and Pb Free) |  |
| Output Voltage                       |  |
| 15 : 1.5V                            |  |
| 16 : 1.6V                            |  |
| :                                    |  |
| 49 : 4.9V                            |  |
| 50 : 5.0V                            |  |
| Use external switch                  |  |
| Use internal switch                  |  |

Note :

Richtek products are :

- ▶ RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- ▶ Suitable for use in SnPb or Pb-free soldering processes.

## Marking Information

For marking information, contact our sales representative directly or through a Richtek distributor located in your area.

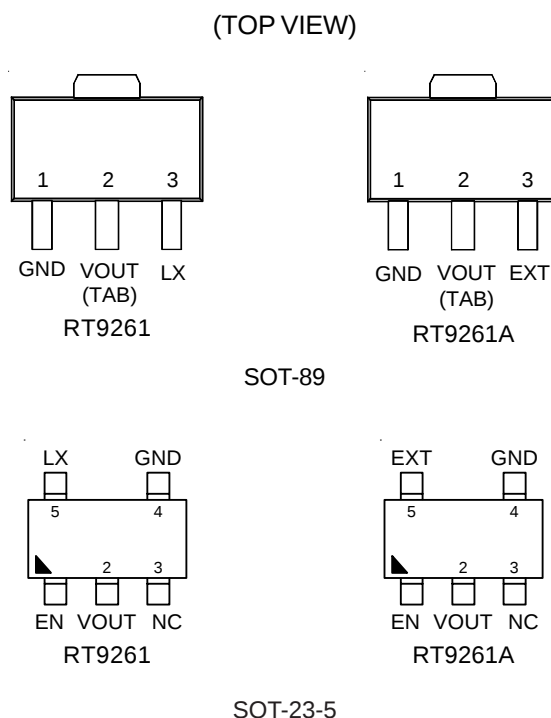
## Features

- Minimal Number of External Components ( Only an Inductor, a Diode, and a Capacitor)
- Ultra Low Input Current ( 5 $\mu$ A at Switch Off)
- $\pm 2\%$  High Output Voltage Accuracy
- Low Ripple and Low Noise
- Low Start-up Voltage, 0.85V at 1mA
- 75% Efficiency with Low Cost Inductor
- +50 ppm/  $^{\circ}$ C Low Temperature-Drift
- SOT-89 and SOT-23-5 Small Packages
- RoHS Compliant and 100% Lead (Pb)-Free

## Applications

- Power source for battery-powered equipment
- Power source for cameras, camcorders, VCRs, PDAs, pagers, electronic data banks, and hand-held communication equipment
- Power source for applications, which require higher voltage than that of batteries used in the appliances

## Pin Configurations



## Typical Application Circuit

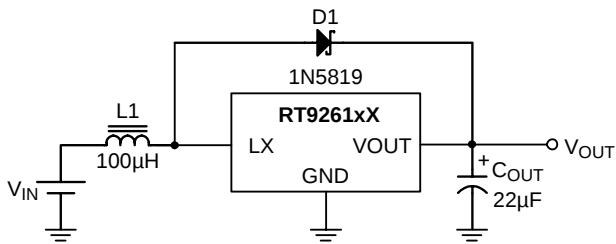


Figure 1

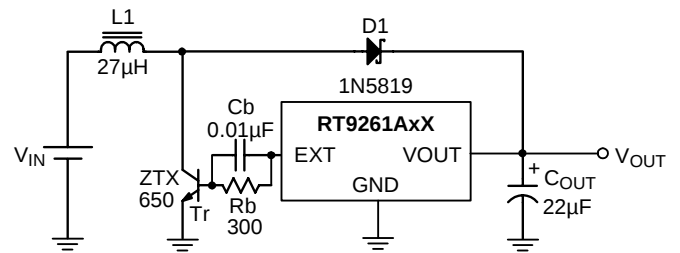


Figure 2

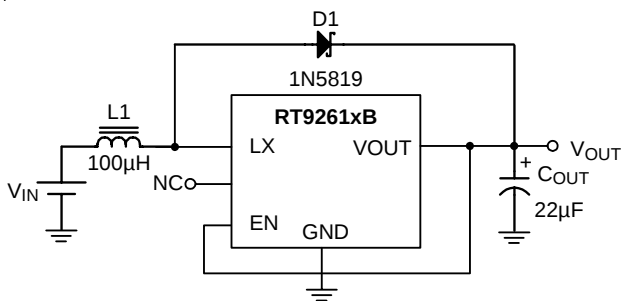


Figure 3

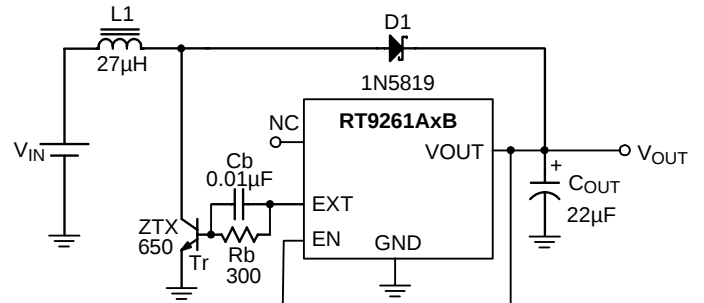


Figure 4

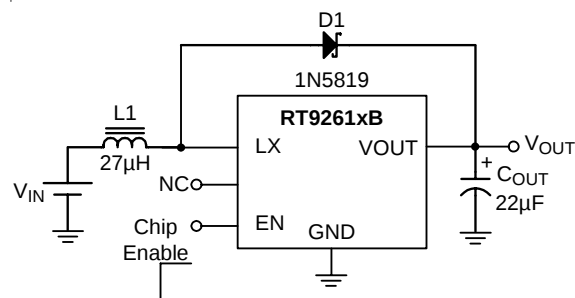
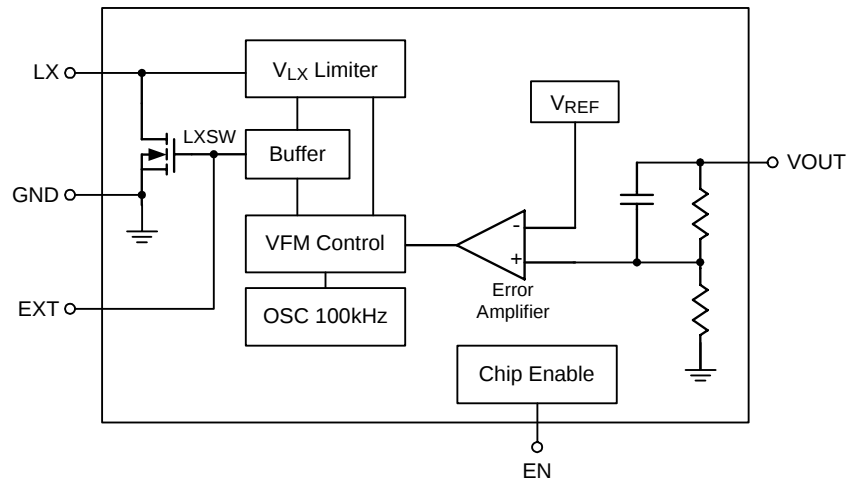


Figure 5

## Functional Pin Description

| Pin No.     |              |             |              | Pin Name | Pin Function               |
|-------------|--------------|-------------|--------------|----------|----------------------------|
| RT9261-□□□X | RT9261A-□□□X | RT9261-□□□B | RT9261A-□□□B |          |                            |
| 1           | 1            | 4           | 4            | GND      | Ground.                    |
| 2           | 2            | 2           | 2            | VOUT     | Output Voltage.            |
| 3           | --           | 5           | --           | LX       | Pin for Switching.         |
| --          | 3            | --          | 5            | EXT      | Drive External Device.     |
| --          | --           | 1           | 1            | EN       | Chip Enable (Active High). |
| --          | --           | 3           | 3            | NC       | No Internal Connected.     |

## Function Block Diagram



### Notes:

- (1) LX Pin..... only for 9261-□□xX and 9261-□□xB
- (2) EXT Pin.... only for 9261A-□□xX and 9261A-□□xB
- (3) EN Pin..... only for 9261-□□xB and 9261A-□□xB

## Absolute Maximum Ratings

- Output Voltage ----- 8V
- LX Pin Voltage <sup>(1)</sup> ----- 8V
- EXT Pin Voltage <sup>(2)</sup> ----- -0.3 to V<sub>OUT</sub> + 0.3V
- EN Pin Voltage <sup>(3)</sup> ----- -0.3 to V<sub>OUT</sub> + 0.3V
- LX Pin Output Current <sup>(1)</sup> ----- 250mA
- EXT Pin Current <sup>(2)</sup> ----- ±50mA
- Power Dissipation, P<sub>D</sub> @ T<sub>A</sub> = 25°C
  - SOT-89 ----- 0.5W
  - SOT-23-5 ----- 0.25W
- Package Thermal Resistance
  - SOT-89, θ<sub>JC</sub> ----- 100°C/W
  - SOT-89, θ<sub>JA</sub> ----- 300°C/W
  - SOT-23-5, θ<sub>JA</sub> ----- 250°C/W
- Operating Temperature Range ----- -20 to +85°C
- Storage Temperature Range ----- 165°C
- Lead Temperature (Soldering, 10 sec.) ----- 260°C

Notes:

(1) Applicable to RT9261-□□xX and RT9261-□□xB

(2) Applicable to RT9261A-□□xX and RT9261A-□□xB

(3) Applicable to RT9261-□□xB and RT9261A-□□xB

## Electrical Characteristics (Refer to Figure 1)

| Parameter               | Symbol           | Test Conditions                                        |                                              | Min  | Typ  | Max | Unit          |
|-------------------------|------------------|--------------------------------------------------------|----------------------------------------------|------|------|-----|---------------|
| Output Voltage Accuracy | $\Delta V_{OUT}$ |                                                        |                                              | -2   | --   | 2   | %             |
| Input Voltage           | $V_{IN}$         |                                                        |                                              | --   | --   | 7   | V             |
| Start-up Voltage        | $V_{ST}$         | $I_{OUT} = 1\text{mA}$ , $V_{IN}$ : 0 $\rightarrow$ 2V |                                              | --   | 0.85 | 1   | V             |
| Hold-on Voltage         | $V_{HO}$         | $I_{OUT} = 1\text{mA}$ , $V_{IN}$ : 2 $\rightarrow$ 0V |                                              | 0.7  | --   | --  | V             |
| Input Current 1         |                  | $V_{IN}$ at no load                                    | $V_{OUT} \leq 3.5\text{V}^{(1)}$             | --   | 15   | 18  | $\mu\text{A}$ |
|                         |                  |                                                        | $3.5\text{V} < V_{OUT} \leq 5\text{V}^{(2)}$ | --   | 18   | 24  |               |
| Input Current 2         |                  | $V_{OUT}$ in switch off condition                      |                                              | --   | 5    | 8   | $\mu\text{A}$ |
| LX Switching Current    | $I_{SWITCHING}$  | $V_{LX} = 0.4\text{V}$                                 | $V_{OUT} \leq 3.5\text{V}^{(1)}$             | 60   | --   | --  | mA            |
|                         |                  |                                                        | $3.5\text{V} < V_{OUT} \leq 5\text{V}^{(2)}$ | 80   | --   | --  |               |
| LX Leakage Current      | $I_{LEAKAGE}$    | $V_{LX} = 6\text{V}$                                   |                                              | --   | --   | 0.5 | $\mu\text{A}$ |
| Maximum Oscillator      | $F_{MAX}$        |                                                        |                                              | 80   | 120  | 160 | kHz           |
| Oscillator Duty Cycle   | $D_{OSC}$        | On ( $V_{LX}$ " L " ) side                             | $V_{OUT} = 2.5\text{V}$ to 5V                | 65   | 75   | 85  | %             |
|                         |                  |                                                        | $V_{OUT} = 1.5\text{V}$ to 2.4V              | 60   | 70   | 80  | %             |
| Efficiency              |                  |                                                        |                                              | --   | 75   | --  | %             |
| $V_{LX}$ Voltage Limit  |                  | $L_X$ switch on                                        |                                              | 0.65 | 0.8  | 1   | V             |

Notes:

(1) Unless otherwise provided, V<sub>IN</sub> = 1.8V, V<sub>SS</sub> = 0V, I<sub>OUT</sub> = 10mA, T<sub>OPT</sub> = 25°C, and External Circuit of Typical Application

(2) Unless otherwise provided, V<sub>IN</sub> = 3V, V<sub>SS</sub> = 0V, I<sub>OUT</sub> = 10mA, T<sub>OPT</sub> = 25°C, and External Circuit of Typical Application

**Electrical Characteristics** (Refer to Figure 2)

| Parameter                    | Symbol           | Test Conditions                            |                                | Min  | Typ  | Max | Unit    |
|------------------------------|------------------|--------------------------------------------|--------------------------------|------|------|-----|---------|
| Output Voltage Accuracy      | $\Delta V_{OUT}$ |                                            |                                | -2   | --   | +2  | %       |
| Input Voltage                | $V_{IN}$         |                                            |                                | --   | --   | 7   | V       |
| Start-up Voltage             | $V_{ST}$         | $I_{OUT} = 1mA, V_{IN} : 0 \rightarrow 2V$ |                                | --   | 0.85 | 1.0 | V       |
| Input Current 1              |                  | $V_{IN}$ at no load                        | $V_{OUT} \leq 3.5V^{(1)}$      | --   | 30   | 50  | $\mu A$ |
|                              |                  |                                            | $3.5V < V_{OUT} \leq 5V^{(2)}$ | --   | 60   | 90  |         |
| Input Current 2              |                  | $V_{OUT}$ in switch off condition          | $V_{OUT} \leq 3.5V^{(1)}$      | --   | 6    | 10  | $\mu A$ |
|                              |                  |                                            | $3.5V < V_{OUT} \leq 5V^{(2)}$ |      |      |     |         |
| EXT "H" Output Current       |                  | $V_{EXT} = V_{OUT} - 0.4V$                 | $V_{OUT} \leq 3.5V^{(1)}$      | -1.5 | --   | --  | mA      |
|                              |                  |                                            | $3.5V < V_{OUT} \leq 5V^{(2)}$ | -2   | --   | --  |         |
| EXT "L" Output Current       |                  | $V_{EXT} = 0.4V$                           | $V_{OUT} \leq 3.5V^{(1)}$      | 1.5  | --   | --  | mA      |
|                              |                  |                                            | $3.5V < V_{OUT} \leq 5V^{(2)}$ | 2    | --   | --  |         |
| Maximum Oscillator Frequency | $F_{MAX}$        |                                            |                                | 80   | 120  | 160 | kHz     |
| Oscillator Duty Cycle        | $D_{OSC}$        | $V_{EXT}$ "H" side                         | $V_{OUT} = 2.5V$ to $5V$       | 65   | 75   | 85  | %       |
|                              |                  |                                            | $V_{OUT} = 1.5V$ to $2.4V$     | 60   | 70   | 80  | %       |

Notes:

(1)Unless otherwise provided,  $V_{IN} = 1.8V$ ,  $V_{SS} = 0V$ ,  $I_{OUT} = 10mA$ ,  $T_{OPT} = 25^{\circ}C$ , and use External Circuit of Typical Application

(2)Unless otherwise provided,  $V_{IN} = 3V$ ,  $V_{SS} = 0V$ ,  $I_{OUT} = 10mA$ ,  $T_{OPT} = 25^{\circ}C$ , and External Circuit of Typical Application

**Electrical Characteristics** (Refer to Figure 3)

| Parameter                    | Symbol           | Test Conditions                                             |                                              | Min             | Typ  | Max | Unit          |
|------------------------------|------------------|-------------------------------------------------------------|----------------------------------------------|-----------------|------|-----|---------------|
| Output Voltage Accuracy      | $\Delta V_{OUT}$ |                                                             |                                              | −2              | --   | +2  | %             |
| Input Voltage                | $V_{IN}$         |                                                             |                                              | --              | --   | 7   | V             |
| Start-up Voltage             | $V_{ST}$         | $I_{OUT} = 1\text{mA}$ , $V_{IN} : 0 \rightarrow 2\text{V}$ |                                              | --              | 0.85 | 1.0 | V             |
| Hold-on Voltage              | $V_{HO}$         | $I_{OUT} = 1\text{mA}$ , $V_{IN} : 2 \rightarrow 0\text{V}$ |                                              | 0.7             | --   | --  | V             |
| Efficiency                   |                  | $V_{OUT} \leq 3.5\text{V}^{(1)}$                            |                                              | --              | 75   | --  | %             |
|                              |                  | $3.5\text{V} < V_{OUT} \leq 5\text{V}^{(2)}$                |                                              | --              | 85   | --  |               |
| Input Current 1              |                  | $V_{IN}$ at no load                                         | $V_{OUT} \leq 3.5\text{V}^{(1)}$             | --              | 15   | 18  | $\mu\text{A}$ |
|                              |                  |                                                             | $3.5\text{V} < V_{OUT} \leq 5\text{V}^{(2)}$ | --              | 18   | 24  |               |
| Input Current 2              |                  | $V_{OUT}$ in switch off condition                           | $V_{OUT} \leq 3.5\text{V}^{(1)}$             | --              | 5    | 8   | $\mu\text{A}$ |
|                              |                  |                                                             | $3.5\text{V} < V_{OUT} \leq 5\text{V}^{(2)}$ | --              | 6    | 10  |               |
| LX Switching Current         | $I_{SWITCHING}$  | $V_{LX} = 0.4\text{V}$                                      | $V_{OUT} \leq 3.5\text{V}^{(1)}$             | 60              | --   | --  | mA            |
|                              |                  |                                                             | $3.5\text{V} < V_{OUT} \leq 5\text{V}^{(2)}$ | 80              | --   | --  |               |
| LX Leakage Current           | $I_{LEAKAGE}$    | $V_{LX} = 6\text{V}$                                        |                                              | --              | --   | 0.5 | $\mu\text{A}$ |
| EN “H” Level                 |                  | $V_{IN} = V_{OUT} \times 0.9$                               |                                              | 0.4 x $V_{OUT}$ | --   | --  | V             |
| EN “L” Level                 |                  | $V_{IN} = V_{OUT} \times 0.9$                               |                                              | --              | --   | 0.2 | V             |
| EN “H” Input Current         |                  | $EN = V_{OUT}$                                              |                                              | --              | --   | 0.5 | $\mu\text{A}$ |
| EN “L” Input Current         |                  | $EN = 0\text{V}$                                            |                                              | −0.5            | --   | --  | $\mu\text{A}$ |
| Maximum Oscillator Frequency | $F_{MAX}$        |                                                             |                                              | 80              | 120  | 160 | kHz           |
| Oscillator Duty Cycle        | $D_{OSC}$        | On ( $V_{LX}$ ”L”) side                                     | $V_{OUT} = 2.5\text{V}$ to 5V                | 65              | 75   | 85  | %             |
|                              |                  |                                                             | $V_{OUT} = 1.5\text{V}$ to 2.4V              | 60              | 70   | 80  | %             |
| $V_{LX}$ Voltage Limit       |                  | LX switch on                                                |                                              | 0.65            | 0.8  | 1.0 | V             |

## Notes:

(1) Unless otherwise provided,  $V_{IN} = 1.8\text{V}$ ,  $V_{SS} = 0\text{V}$ ,  $I_{OUT} = 10\text{mA}$ ,  $T_{OPT} = 25^\circ\text{C}$ , and use External Circuit of Typical Application

(2) Unless otherwise provided,  $V_{IN} = 3\text{V}$ ,  $V_{SS} = 0\text{V}$ ,  $I_{OUT} = 10\text{mA}$ ,  $T_{OPT} = 25^\circ\text{C}$ , and External Circuit of Typical Application

**Electrical Characteristics** (Refer to Figure 4)

| Parameter                    | Symbol           | Test Conditions                               |                                | Min                  | Typ  | Max | Unit    |
|------------------------------|------------------|-----------------------------------------------|--------------------------------|----------------------|------|-----|---------|
| Output Voltage Accuracy      | $\Delta V_{OUT}$ |                                               |                                | -2                   | --   | +2  | %       |
| Input Voltage                | $V_{IN}$         |                                               |                                | --                   | --   | 7   | V       |
| Start-up Voltage             | $V_{ST}$         | $I_{OUT} = 1mA$ , $V_{IN} : 0 \rightarrow 2V$ |                                | --                   | 0.85 | 1.0 | V       |
| Efficiency                   |                  | $V_{OUT} \leq 3.5V^{(1)}$                     |                                | --                   | 75   | --  | %       |
|                              |                  | $3.5V < V_{OUT} \leq 5V^{(2)}$                |                                | --                   | 85   | --  |         |
| Input Current 1              |                  | $V_{IN}$ at no load                           | $V_{OUT} \leq 3.5V^{(1)}$      | --                   | 30   | 50  | $\mu A$ |
|                              |                  |                                               | $3.5V < V_{OUT} \leq 5V^{(2)}$ | --                   | 60   | 90  |         |
| Input Current 2              |                  | $V_{OUT}$ in switch off condition             | $V_{OUT} \leq 3.5V^{(1)}$      | --                   | 6    | 10  | $\mu A$ |
|                              |                  |                                               | $3.5V < V_{OUT} \leq 5V^{(2)}$ |                      |      |     |         |
| EXT "H" Output Current       |                  | $V_{EXT} = V_{OUT} - 0.4V$                    | $V_{OUT} \leq 3.5V^{(1)}$      | -1.5                 | --   | --  | mA      |
|                              |                  |                                               | $3.5V < V_{OUT} \leq 5V^{(2)}$ | -2                   | --   | --  |         |
| EXT "L" Output Current       |                  | $V_{EXT} = 0.4V$                              | $V_{OUT} \leq 3.5V^{(1)}$      | 1.5                  | --   | --  | mA      |
|                              |                  |                                               | $3.5V < V_{OUT} \leq 5V^{(2)}$ | 2                    | --   | --  |         |
| EN "H" Level                 |                  | $V_{IN} = V_{OUT} \times 0.9$                 |                                | $0.4 \times V_{OUT}$ | --   | --  | V       |
| EN "L" Level                 |                  | $V_{IN} = V_{OUT} \times 0.9$                 |                                | --                   | --   | 0.2 | V       |
| EN "H" Input Current         |                  | $EN = V_{OUT}$                                |                                | --                   | --   | 0.5 | $\mu A$ |
| EN "L" Input Current         |                  | $EN = 0V$                                     |                                | -0.5                 | --   | --  | $\mu A$ |
| Maximum Oscillator Frequency | $F_{MAX}$        |                                               |                                | 80                   | 120  | 160 | kHz     |
| Oscillator Duty Cycle        | $D_{OSC}$        | On ( $V_{LX}$ "L" ) side                      | $V_{OUT} = 2.5V$ to $5V$       | 65                   | 75   | 85  | %       |
|                              |                  |                                               | $V_{OUT} = 1.5V$ to $2.4V$     | 60                   | 70   | 80  | %       |
| $V_{LX}$ Voltage Limit       |                  | LX switch on                                  |                                | 0.65                 | 0.8  | 1.0 | V       |

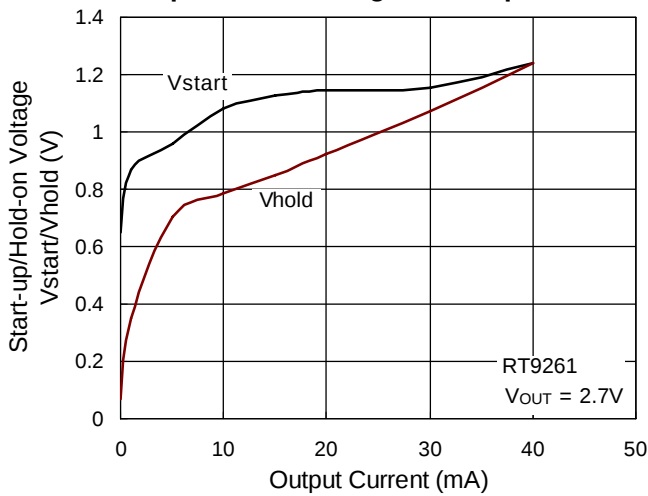
Notes:

(1)Unless otherwise provided,  $V_{IN} = 1.8V$ ,  $V_{SS} = 0V$ ,  $I_{OUT} = 10mA$ ,  $T_{OPT} = 25^{\circ}C$ , and use External Circuit of Typical Application

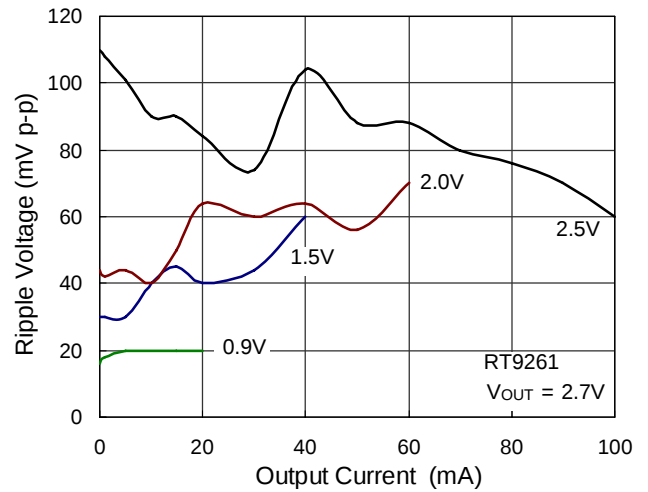
(2)Unless otherwise provided,  $V_{IN} = 3V$ ,  $V_{SS} = 0V$ ,  $I_{OUT} = 10mA$ ,  $T_{OPT} = 25^{\circ}C$ , and External Circuit of Typical Application

## Typical Operating Characteristics

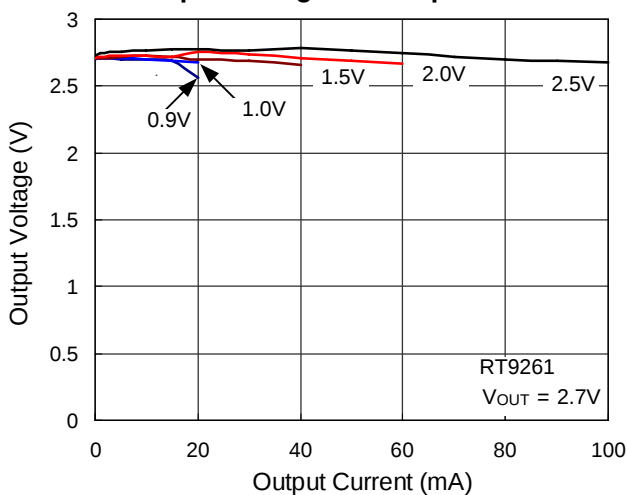
Start-up/Hold-on Voltage vs. Output Current



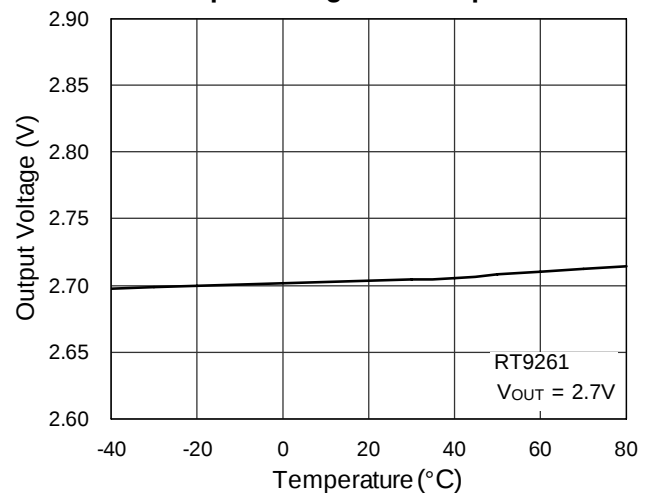
Output Current vs. Ripple Voltage



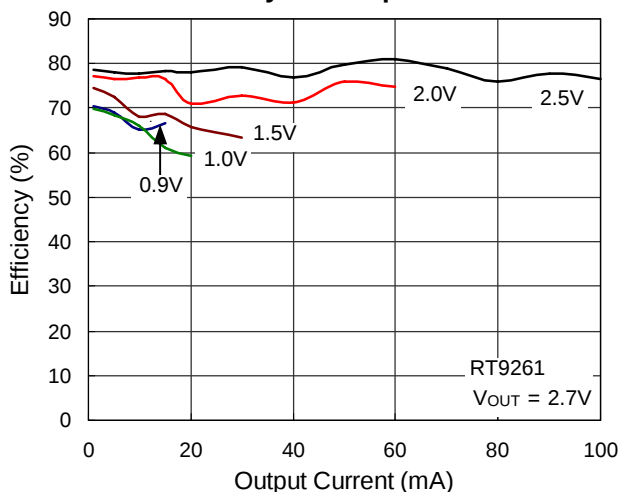
Output Voltage vs. Output Current



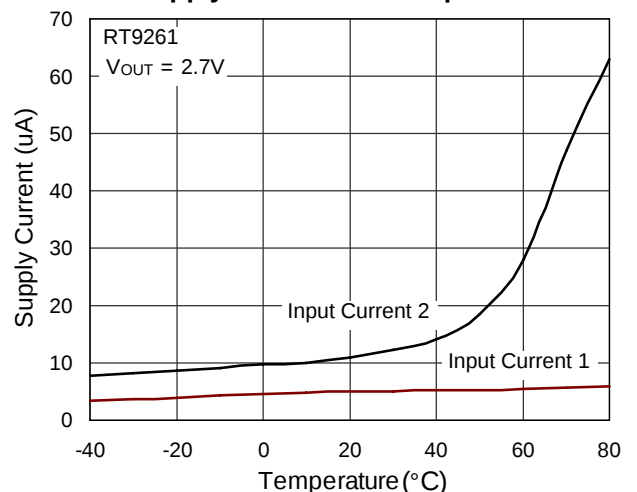
Output Voltage vs. Temperature



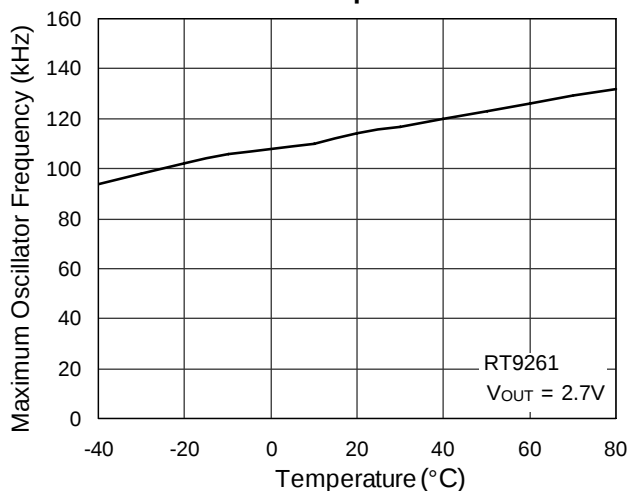
Efficiency vs. Output Current



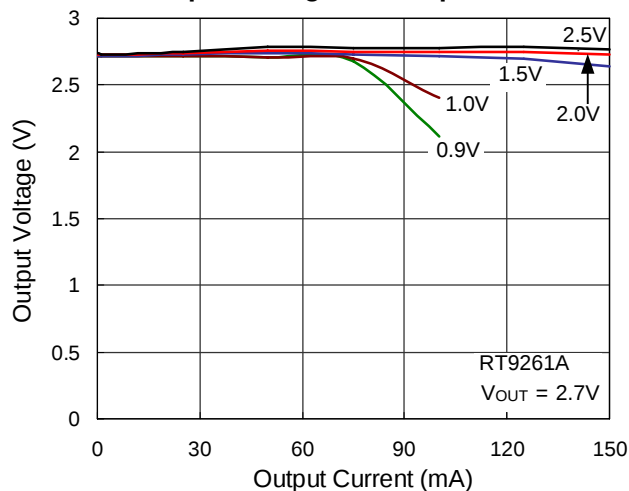
Supply Current vs. Temperature



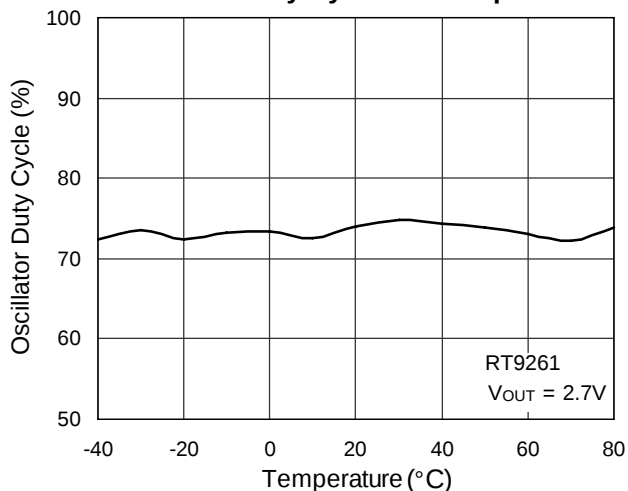
Maximum Oscillator Frequency  
vs. Temperature



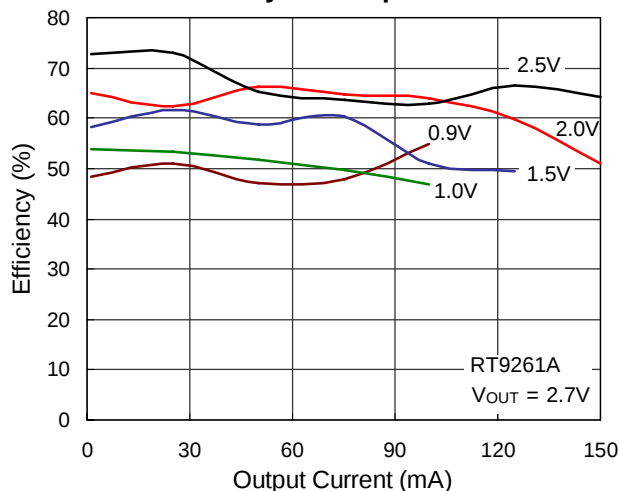
Output Voltage vs. Output Current



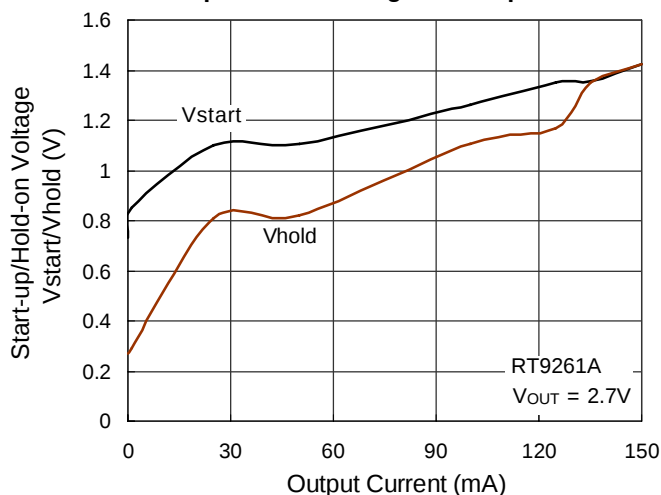
Oscillator Duty Cycle vs. Temperature



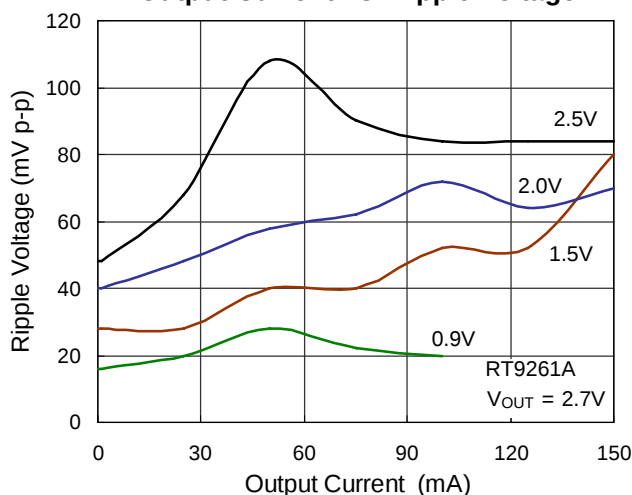
Efficiency vs. Output Current



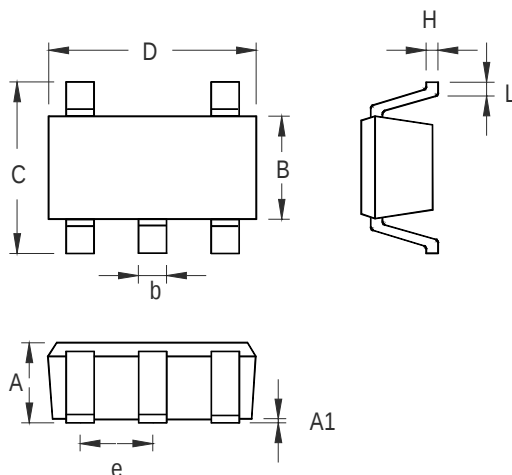
Start-up/Hold-on Voltage vs. Output Current



Output Current vs. Ripple Voltage

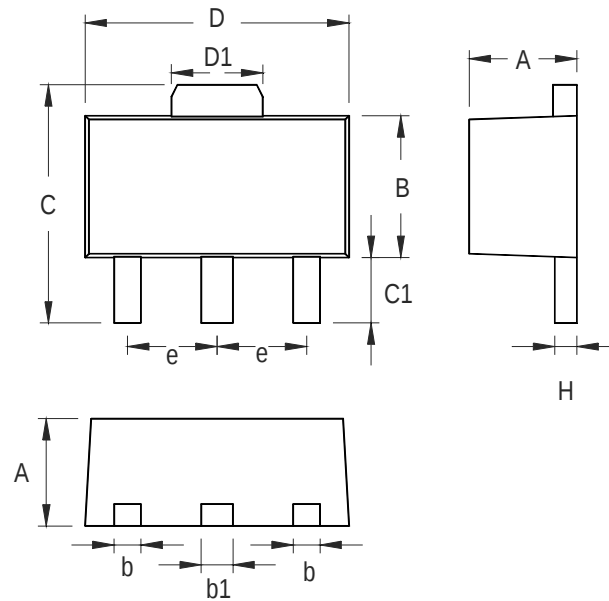


## Outline Dimension



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 0.889                     | 1.295 | 0.035                | 0.051 |
| A1     | 0.000                     | 0.152 | 0.000                | 0.006 |
| B      | 1.397                     | 1.803 | 0.055                | 0.071 |
| b      | 0.356                     | 0.559 | 0.014                | 0.022 |
| C      | 2.591                     | 2.997 | 0.102                | 0.118 |
| D      | 2.692                     | 3.099 | 0.106                | 0.122 |
| e      | 0.838                     | 1.041 | 0.033                | 0.041 |
| H      | 0.080                     | 0.254 | 0.003                | 0.010 |
| L      | 0.300                     | 0.610 | 0.012                | 0.024 |

SOT-23-5 Surface Mount Package



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 1.397                     | 1.600 | 0.055                | 0.063 |
| b      | 0.356                     | 0.483 | 0.014                | 0.019 |
| B      | 2.388                     | 2.591 | 0.094                | 0.102 |
| b1     | 0.406                     | 0.533 | 0.016                | 0.021 |
| C      | 3.937                     | 4.242 | 0.155                | 0.167 |
| C1     | 0.787                     | 1.194 | 0.031                | 0.047 |
| D      | 4.394                     | 4.597 | 0.173                | 0.181 |
| D1     | 1.397                     | 1.753 | 0.055                | 0.069 |
| e      | 1.448                     | 1.549 | 0.057                | 0.061 |
| H      | 0.356                     | 0.432 | 0.014                | 0.017 |

**3-Lead SOT-89 Surface Mount**

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