

MAS9251**Regulated Charge Pump
DC/DC Converter**

This is preliminary information on a new product under development. Micro Analog Systems Oy reserves the right to make any changes without notice.

Preliminary

- **Solution without Inductors**
- **100 mA Output Current**
- **Fixed (5 V) or Adjustable Output Voltage**
- **Low Noise**
- **1 MHz Switching Frequency**
- **$I_{CC} < 1 \mu A$ in Shut Down**
- **MSOP-8 and CSP Packages**

DESCRIPTION

MAS9251 is a low noise, constant frequency switched capacitor voltage doubler with regulated output. In the adjustable output version an external feedback pin allows the output voltage to be adjusted.

The high switching frequency of MAS9251 guarantees low output ripple even with small ceramic capacitors. The shutdown control pin can be used to turn off the device for power saving. MAS9251 is equipped with soft-start feature, which

reduces the circuit's disturbance to power supply lines during start-up by limiting the maximum input current.

Low operating input voltage and low external part count make MAS9251 ideal for small battery powered portable systems. An internal thermal protection circuit prevents the device from overheating. Also the maximum output current is internally limited.

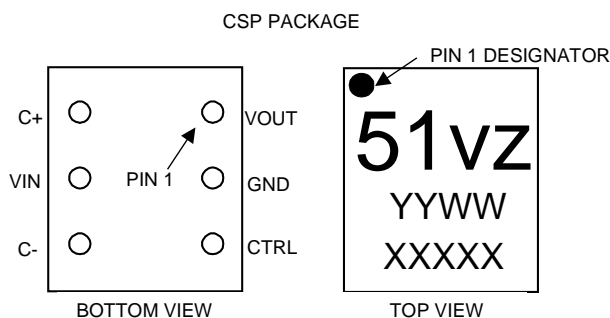
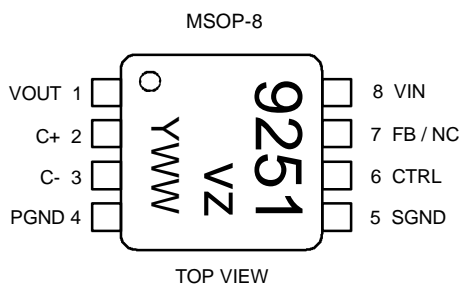
FEATURES

- Two versions:
 - Adjustable Output
 - Fixed 5 V Output
- Solution without Inductors
- Soft-Start
- Output Accuracy $< \pm 4\%$
- Low External Part Count
- Low Noise
- Input Voltage Range: 2.7 V... 4.5 V
- Shutdown Control
- 1 MHz Switching Frequency
- Internal Thermal Shutdown
- Short Circuit Protection
- MSOP-8 and CSP Packages

APPLICATIONS

- LED Backlighting
- White LED Driver
- LED Brightness Control
- Li-Ion Battery Backup Supplies
- Local 3 V to 5 V Conversion
- Smart Card Readers
- PCMCIA Local 5 V Supplies

PIN CONFIGURATION



Top Marking Information:
 vz = Product Specific Code, see p.11 Ordering Information
 (Y)YWW = Year Week
 XXXXX = Lot Number

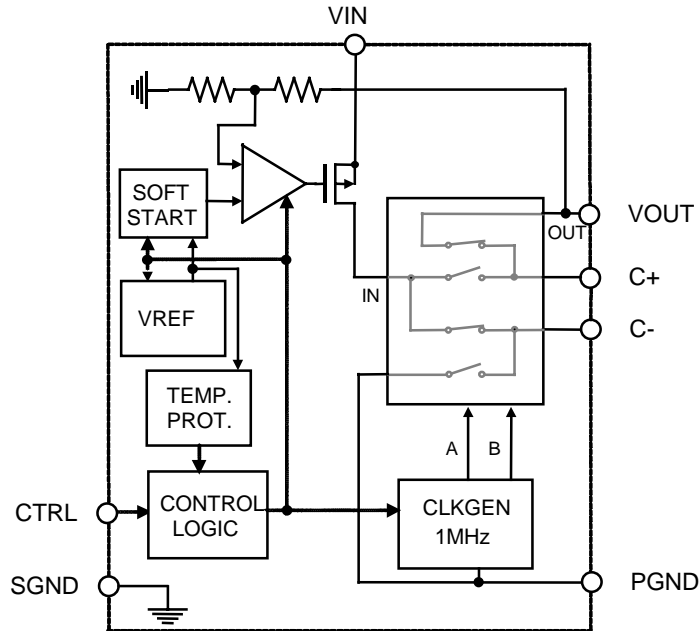
PIN DESCRIPTION

| Pin Name | Pin Number in MSOP-8 | Pin Number in CSP | Type | Function |
|----------|----------------------|-------------------|------|--|
| VOUT | 1 | 1 | O | Regulated Output Voltage |
| C+ | 2 | 6 | I/O | Flying Capacitor Positive Terminal |
| C- | 3 | 4 | I/O | Flying Capacitor Negative Terminal |
| PGND | 4 | 2 | G | Ground for Switching Currents |
| SGND | 5 | - | G | Ground for Analog Blocks |
| CTRL | 6 | 3 | I | Enable/Disable Pin for Charge Pump (Logic 0 = Disable, Logic 1 = Enable) |
| FB | 7 | - | I/O | Feedback Input Pin |
| VIN | 8 | 5 | P | Input Supply Voltage |

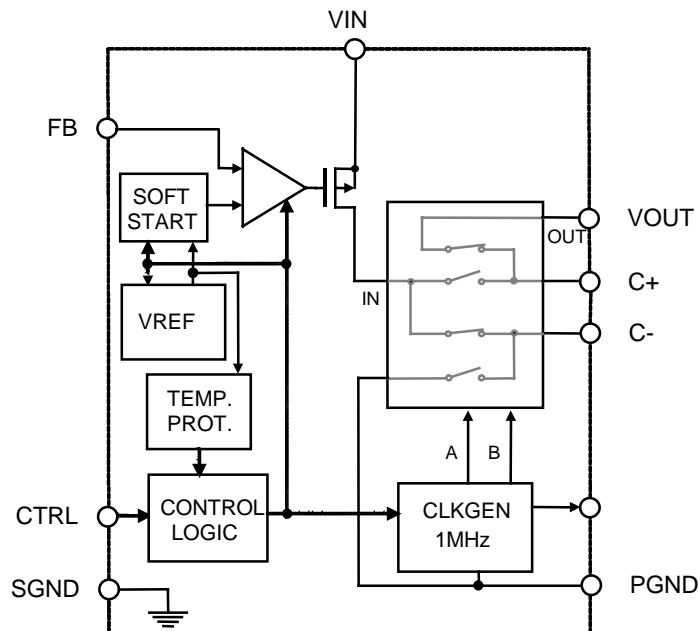
G = Ground, I = Input, O = Output, P = Power

BLOCK DIAGRAM

◆ **MAS9251AF: Fixed 5 V Output Voltage Charge Pump**



◆ **MAS9251AS: Adjustable Output Voltage Charge Pump**



ABSOLUTE MAXIMUM RATINGS

All voltages with respect to ground.

| Parameter | Symbol | Conditions | Min | Max | Unit |
|----------------------------|--------------------|---|--------------|---------------------|------|
| Supply Voltage | V_{IN} | | -0.3 | 6 | V |
| Output Voltage | V_{OUT} | | -0.3 | 6 | V |
| CTRL and FB Input Voltages | V_{CTRL}, V_{FB} | $V_{IN} \leq 5.7\text{ V}$ $5.7\text{ V} < V_{IN} \leq 6\text{ V}$ | -0.3 -0.3 | $V_{IN} + 0.3$ 6 | V |
| ESD Rating | | Human Body Model (HBM) | | 2 | kV |
| Junction Temperature | T_{Jmax} | | | +175 (limited) | °C |
| Storage Temperature | T_S | | -55 | +150 | °C |
| Short Circuit Duration | t_{SC} | | Indefinite | | s |

Stresses beyond those listed may cause permanent damage to the device. The device may not operate under these conditions, but it will not be destroyed.

RECOMMENDED OPERATING CONDITIONS

All voltages with respect to ground.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|--------------------------------|-----------|--|------|-----|------|------|
| Operating Junction Temperature | T_J | | -40 | | +125 | °C |
| Operating Ambient Temperature | T_A | | -40 | +27 | +85 | °C |
| Operating Supply Voltage | V_{IN} | For MAS9251AF For MAS9251AS see application information p 7 | 2.7 | 3.6 | 4.5 | V |
| Output Voltage | V_{OUT} | For adjustable output version | 0.84 | | 5.3 | |

ELECTRICAL CHARACTERISTICS

 $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, typical values at $T_A = 27^\circ\text{C}$, $V_{IN} = 3.6\text{ V}$, $V_{OUT} = 5.0\text{ V}$, $C_{IN} = 1\ \mu\text{F}$, $C_{FLY} = 1\ \mu\text{F}$, $C_{OUT} = 1\ \mu\text{F}$, $V_{CTRL} = V_{IN}$, unless otherwise specified.

◆ Voltage Parameters

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|----------------------------|-----------|--|----------|------|----------|-------------------|
| Output Voltage Tolerance | V_{OUT} | $V_{IN} = 2.7\text{ V} \dots 4.5\text{ V}$, $I_{OUT} \leq 40\text{ mA}$ $V_{IN} = 3.1\text{ V} \dots 4.5\text{ V}$, $I_{OUT} = 100\text{ mA}$ | -4 -4 | | +4 +4 | % V_{NOM} |
| Output Voltage Ripple | V_R | $V_{IN} = 3\text{ V}$, $I_{OUT} = 100\text{ mA}$ | | 80 | | mV _{P-P} |
| Feedback Voltage Reference | V_{FB} | All conditions (internally controlled reference) | | 0.84 | | V |

◆ Current Parameters

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---------------------------|------------|--|-----|------|--------|---------------|
| Continuous Output Current | I_{OUT} | $V_{IN} = 3.1\text{ V} \dots 4.5\text{ V}$ | | | 100 | mA |
| Short Circuit Current | I_{SC} | $V_{IN} = 3.6\text{ V}$, $R_L = 0\ \Omega$ | | 300 | | mA |
| Feedback Input Current | I_{FB} | $V_{FB} = 0.84\text{ V}$ | | | 0.1 | μA |
| Current Consumption | I_{CC} | $I_{OUT} = 0\text{ mA}$ | | 4.5 | | mA |
| Shutdown Current | I_{SHDN} | $V_{CTRL} = 0\text{ V}$, $V_{OUT} = 0\text{ V}$ $T_A = +27^\circ\text{C}$ $T_A = +85^\circ\text{C}$ | | 0.01 | 1 5 | μA |

◆ Thermal Protection

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|----------------|--------|------------|-----|-----|-----|------|
| Threshold High | T_H | | 145 | 160 | 175 | °C |
| Threshold Low | T_L | | 135 | 150 | 165 | °C |

The hysteresis of 10 °C prevents the device from turning on too soon after thermal shut-down.

◆ Shutdown Terminal Specifications

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|------------|---|-------------|--------|------------------------|------|
| Shutdown Voltage OFF State ON State | V_{CTRL} | | -0.3 1.6 | | 0.55 $V_{IN} + 0.3$ | V |
| Shutdown Control Input Pin Current | I_{CTRL} | $V_{CTRL} = V_{IN}$ $V_{CTRL} = 0 V$ | | 4 0 | 10 | μA |

If CTRL-pin is not connected, MAS9251 is in OFF state (900 kΩ pull-down resistor to ground).

◆ Power Dissipation

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|--|----------|---------------------------------|---|-------|-----|------|
| Thermal Resistance MSOP-8 (Junction-to-Air) | R_{JA} | typical PC board mounting | | 206.3 | | °C/W |
| Maximum Power Dissipation | P_d | any ambient temperature | $P_{dMAX} = \frac{T_{JMAX} - T_A}{R_{JA}}$ Note 1 | | | W |
| Efficiency | η | $V_{IN} = 3 V, I_{OUT} = 50 mA$ | | 80 | | % |

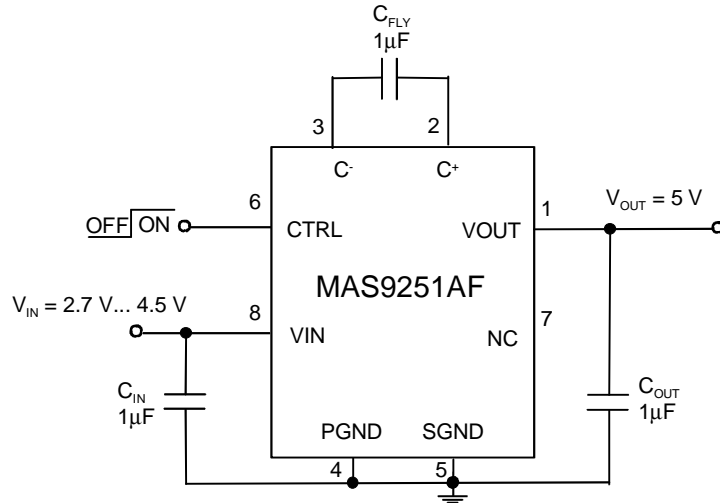
Note 1: $T_{J(MAX)}$ denotes maximum operating junction temperature (+125°C), T_A ambient temperature, and R_{JA} junction-to-air thermal resistance (206.3°C/W).

◆ Dynamic Parameters

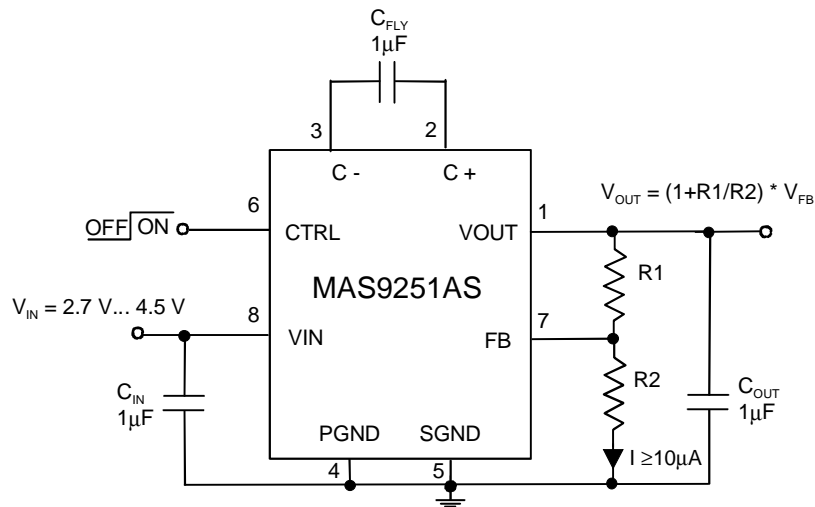
| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|--|----------------|--|-----|-----|-----|------|
| Start-up Time (from control signal edge to 90% of V_{NOM}) | $t_{start-up}$ | $V_{CTRL} = 0$ to V_{IN} , $V_{IN} = 3 V$, $I_{OUT} \leq 100 mA$ | | 1 | | ms |
| Switching Frequency | F_{OSC} | | 0.6 | 1 | 1.8 | MHz |

APPLICATION INFORMATION

◆ Fixed 5 V Voltage Supply



◆ Adjustable Voltage Supply



N.B.! The values of R1 and R2 should be selected so that V_{OUT} does not exceed 5.3 V.

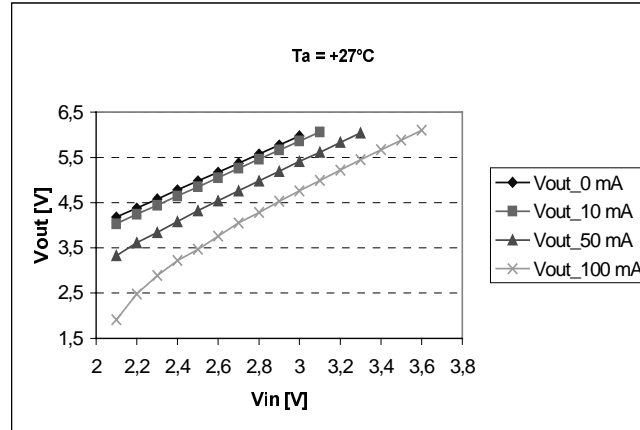
| Parameter | Symbol | Min | Typ | Max | Unit | Note |
|--------------------|-----------|------|-----|-----|---------------|---|
| Output Capacitance | C_{OUT} | 0.47 | 1 | | μF | Low ESR ($< 0.1 \Omega$) ceramic capacitor recommended, especially with high load current |
| Flying Capacitance | C_{FLY} | 0.68 | 1 | | μF | Low ESR ($< 0.1 \Omega$) ceramic capacitor required (note 2) |
| Input Capacitance | C_{IN} | 0.47 | 1 | | μF | Low ESR ($< 0.1 \Omega$) ceramic capacitor recommended, especially with high load current |

Values given on the table are minimum requirements unless otherwise specified. When selecting capacitors, tolerance and temperature coefficient must be considered to make sure that the requirement is met in all potential operating conditions.

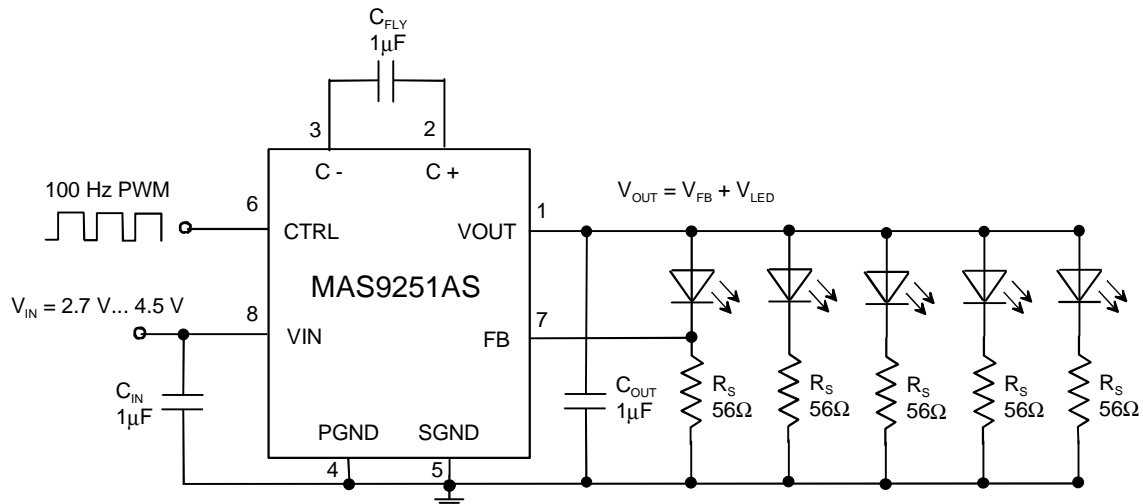
Note 2: Polarized capacitor should never be used, since the capacitor voltage can reverse during operation.

APPLICATION INFORMATION

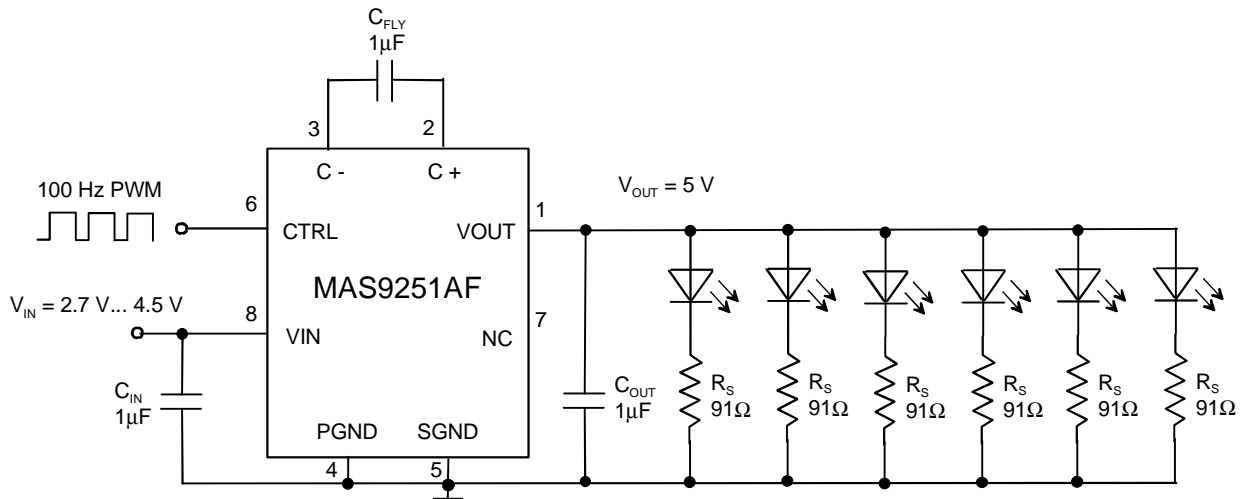
◆ MAS9251AS Max Output Voltage vs. Input Voltage

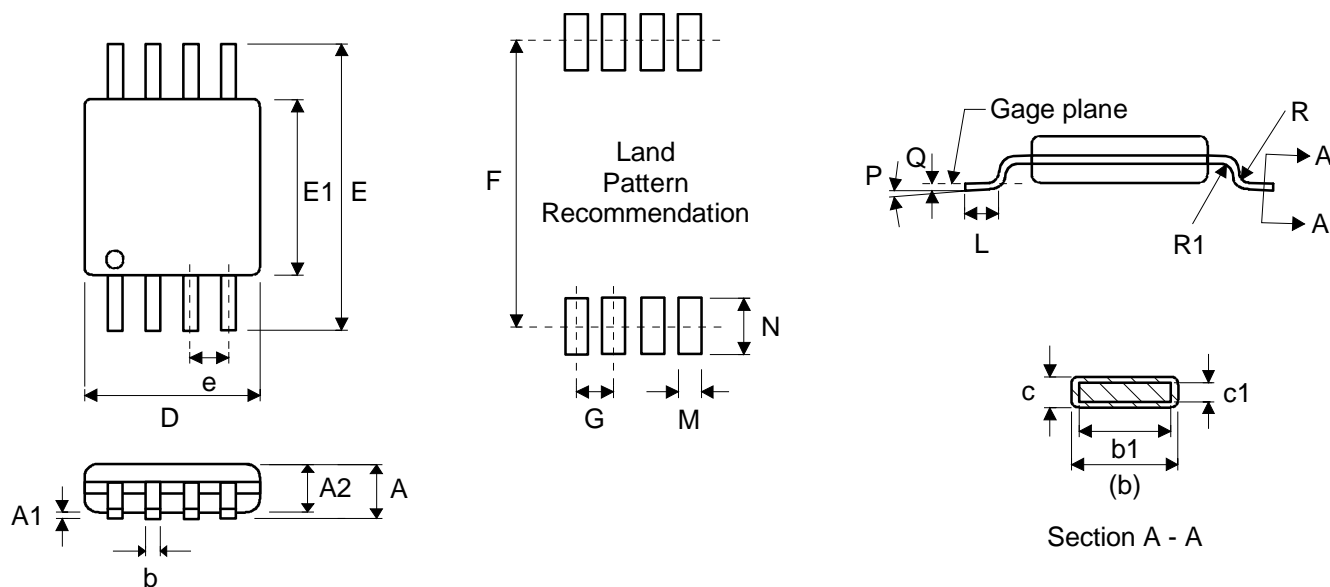


◆ LED Driver with Current Feedback and PWM Brightness Control



◆ White Backlighting LED Driver with Constant 5 V Output and PWM Brightness Control



PACKAGE (MSOP-8) OUTLINE


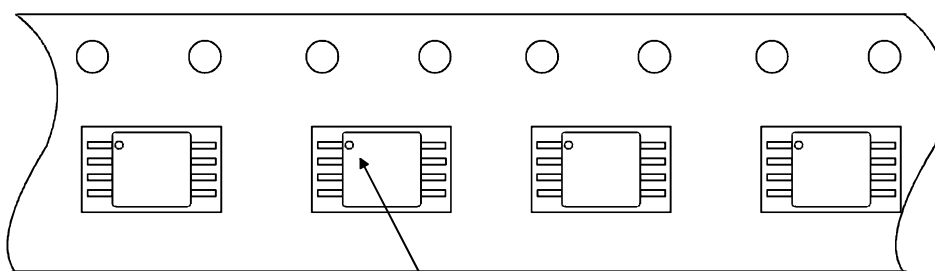
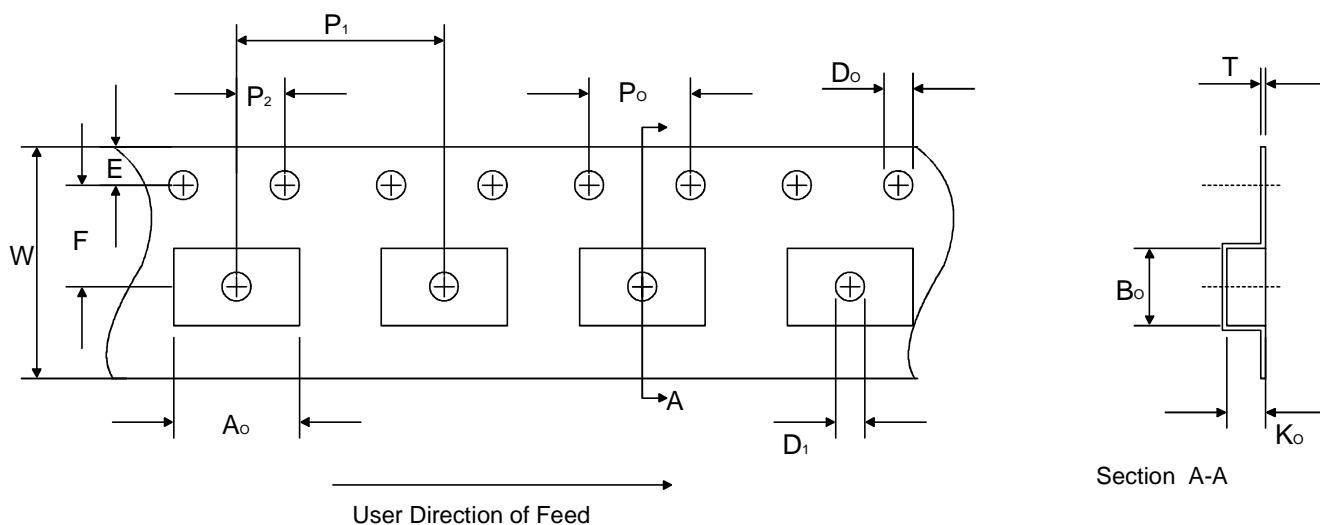
| Symbol | Min | Nom | Max | Unit |
|---------------------------------|------|----------|------|------|
| A | | | 1.10 | mm |
| A1 | 0 | | 0.15 | mm |
| A2 | 0.75 | 0.85 | 0.95 | mm |
| b | 0.22 | | 0.38 | mm |
| b1 | 0.22 | 0.30 | 0.33 | mm |
| c | 0.08 | | 0.23 | mm |
| c1 | 0.08 | | 0.18 | mm |
| D | | 3.00 BSC | | mm |
| E | | 4.90 BSC | | mm |
| E1 | | 3.00 BSC | | mm |
| e | | 0.65 BSC | | mm |
| F | | 4.8 | | mm |
| G | | 0.65 | | mm |
| L | 0.40 | 0.60 | 0.80 | mm |
| (Terminal length for soldering) | | | | |
| M | | 0.41 | | mm |
| N | | 1.02 | | mm |
| P | 0° | | 8° | |
| Q | | 0.25 BSC | | mm |
| R | 0.07 | | | mm |
| R1 | 0.07 | | | mm |

Dimensions do not include mold or interlead flash, protrusions or gate burrs.
 All measurement according to JEDEC standard MO-187.

SOLDERING INFORMATION

| | |
|---------------------------------|---|
| Resistance to Soldering Heat | According to RSH test IEC 68-2-58/20 2*220°C |
| Maximum Reflow Temperature | 235°C |
| Maximum Number of Reflow Cycles | 2 |
| Seating Plane Co-planarity | max 0.08 mm |
| Lead Finish | Solder plate 7.62 - 25.4 µm, material Sn 85% Pb 15% |

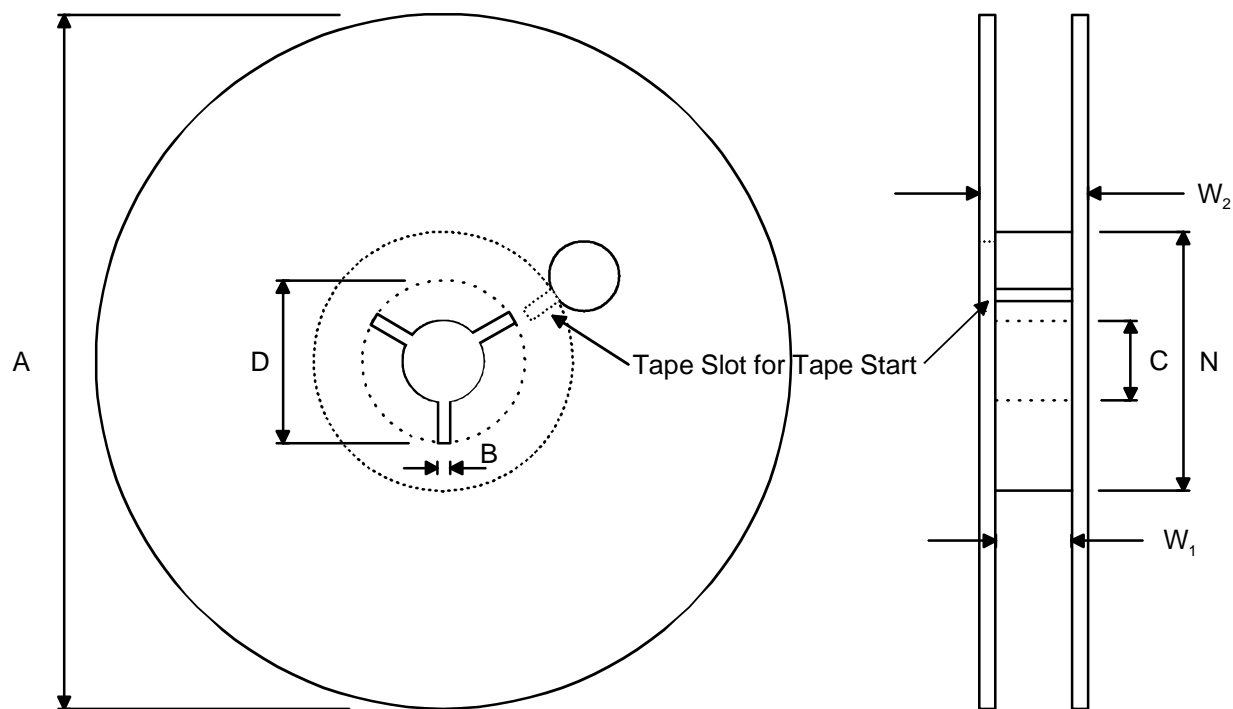
EMBOSSED TAPE SPECIFICATIONS



Pin 1 Designator

| Dimension | Min/Max | Unit |
|-----------|-------------------|------|
| A_o | 5.00 ±0.10 | mm |
| B_o | 3.20 ±0.10 | mm |
| D_o | 1.50 +0.1/-0.0 | mm |
| D_1 | 1.50 min | mm |
| E | 1.75 | mm |
| F | 5.50 ±0.05 | mm |
| K_o | 1.45 ±0.10 | mm |
| P_o | 4.0 | mm |
| P_1 | 8.0 ±0.10 | mm |
| P_2 | 2.0 ±0.05 | mm |
| T | 0.3 ±0.05 | mm |
| W | 12.00 +0.30/-0.10 | mm |

REEL SPECIFICATIONS

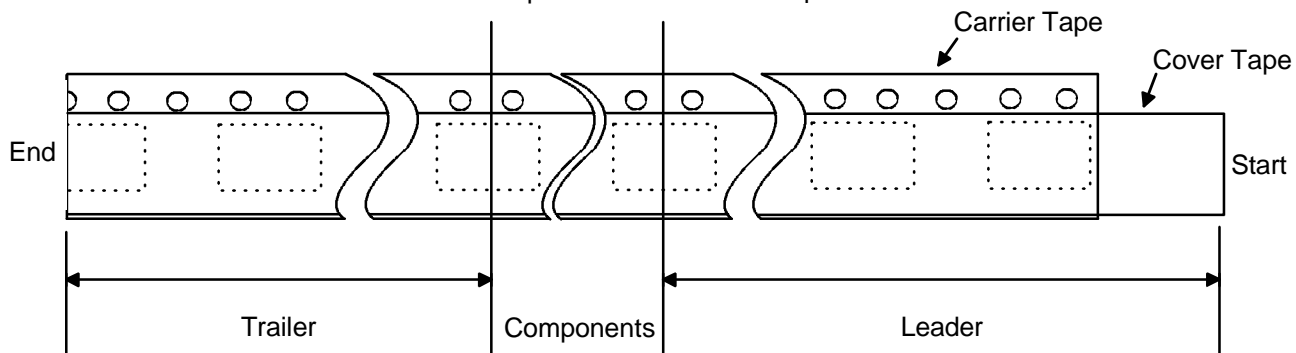


5000 Components on Each Reel

Reel Material: Conductive, Plastic Antistatic or Static Dissipative

Carrier Tape Material: Conductive

Cover Tape Material: Static Dissipative



| Dimension | Min | Max | Unit |
|----------------------------------|--|-------|------|
| A | | 330 | mm |
| B | 1.5 | | mm |
| C | 12.80 | 13.50 | mm |
| D | 20.2 | | mm |
| N | 50 | | mm |
| W ₁ (measured at hub) | 12.4 | 14.4 | mm |
| W ₂ (measured at hub) | | 18.4 | mm |
| Trailer | 160 | | mm |
| Leader | 390, of which minimum 160 mm of empty carrier tape sealed with cover tape | | mm |
| Weight | | 1500 | g |

ORDERING INFORMATION

| Product Code | Product | Top Marking (vz) | Package | Comments |
|---------------|---------------------------------------|------------------|---|---------------|
| MAS9251ASMF-T | Fixed 5 V Output Voltage Charge Pump | AF (T1) | MSOP-8 | Tape and Reel |
| MAS9251ASMS-T | Adjustable Output Voltage Charge Pump | AS (T2) | MSOP-8 | Tape and Reel |
| MAS9251ACAF-T | Fixed 5 V Output Voltage Charge Pump | AF | Chip Scale Package (CSP) (to be qualified) | Tape and Reel |

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