

ML65 Series DC-DC Converter

❖ *General Description*

The ML65 is a group of PWM Step-up DC/DC converter IC with ultra-low supply current by CMOS process.

It consists of an oscillator, a PWM control circuit, a Lx switch driver transistor, a reference voltage unit, an error amplifier for voltage detection and an Lx switch protection circuit. It is suitable for use with battery-powered instruments with low noise and ultra low supply current.

❖ *Features*

- Small number of external components: inductor, diode and capacitor.
- Ultra low input current : Typical 6 μ A
- Output Voltage Accuracy : +/- 2.5 %
- Low ripple and noise
- Low startup voltage : Max 0.9V (with 1mA input)
- High Efficiency: Typical 80%
- Package Available:
SOT-89 (500mW), SOT-23 (150mW) & TO-92 (300mW)

❖ *Application*

- ◆ *Power Source of Portable Products*
- ◆ *Palmtops*
- ◆ *Portable Cameras and Video Recorders*
- ◆ *Wireless mouse and keyboard*

| ML65 Version | Package Designator | Package | Switching Transistor | CE Function | VDD Pin | FB Pin | Features |
|--------------|--------------------|---------|----------------------|-------------|---------|--------|----------|
| ML65A | M | SOT23-3 | Build-in Transistor | No | No | No | Lx |
| | P | SOT89-3 | | | | | |
| | T | TO-92 | | | | | |
| ML65C | M | SOT23-5 | Build-in Transistor | Yes | No | No | Lx+CE |
| | P | SOT89-5 | | | | | |

❖ *Ordering Information*

| Designator | Description |
|------------|--|
| a | Version |
| b | Output Voltage eg. 30=3.0V 33=3.3V 50=5.0V |
| c | Package Type P = SOT-89 M = SOT-23 |
| d | Device Orientation R = Embossed Tape (Orientation of Device : Right) L = Embossed Tape (Orientation of Device : Left) B = Bag (TO-92) |

ML65xxxxx
↑ ↑ ↑ ↑
a b c d

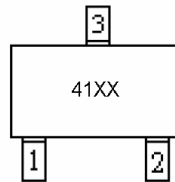
Marking:

SOT23:

ML65Cseries

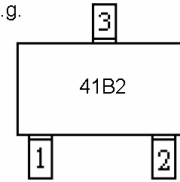
| | Marking | Description |
|------------|---------|-----------------------------------|
| ML65C33MRG | 41XX | XX = Production Date Code e.g. B2 |
| ML65C50MRG | 42XX | |

ML65C33MRG



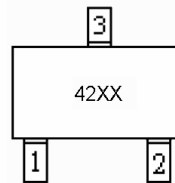
SOT-23 (Top View)

e.g.



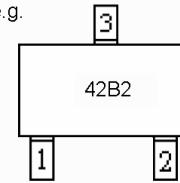
SOT-23 (Top View)

ML65C50MRG



SOT-23 (Top View)

e.g.



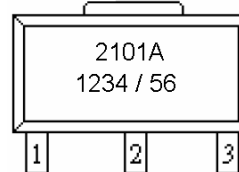
SOT-23 (Top View)

SOT89:

ML65A series

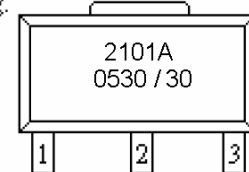
| Designator | Description |
|------------|-----------------------------------|
| 1, 2 | Year Code e.g. 05 = Year 2005 |
| 3, 4 | Week Code e.g. 30 = Week 30 |
| 5, 6 | Output Voltage e.g. 30 = 3.0 V |

ML65A



SOT-89 (Top View)

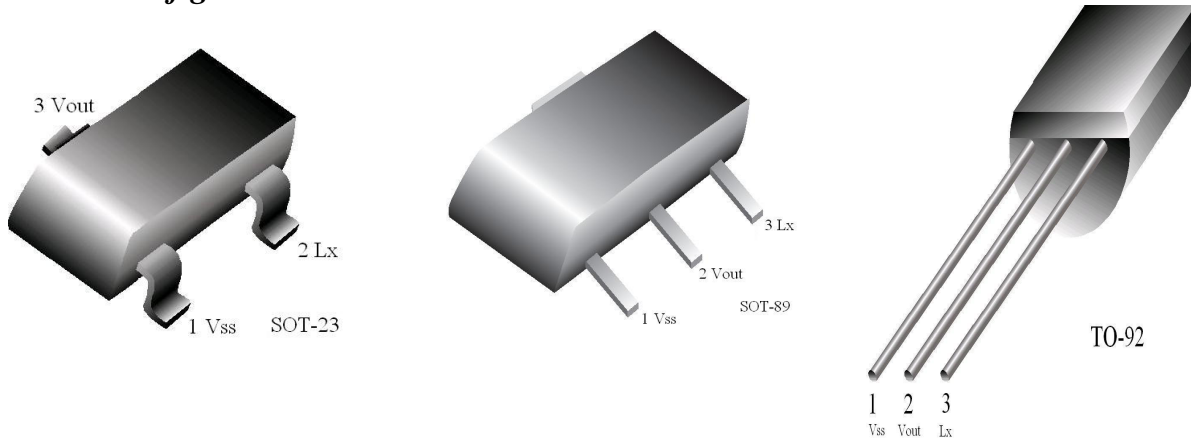
e.g.



SOT-89 (Top View)

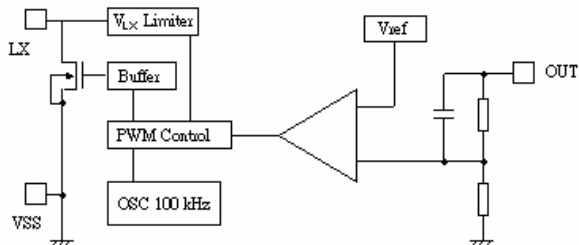
❖ **ML65A**

◆ **Pin Configuration**

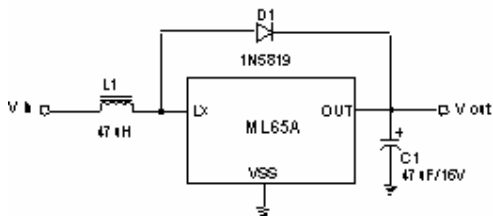


| Package Pin Number | | | Pin Name | Function |
|--------------------|---------|-------|------------------|--|
| SOT23-3 | SOT89-3 | TO-92 | | |
| 1 | 1 | 1 | V _{SS} | Ground |
| 3 | 2 | 2 | V _{OUT} | Output Voltage monitor, Internal IC Power Supply |
| 2 | 3 | 3 | L _X | Switch |

◆ **Block Diagram**

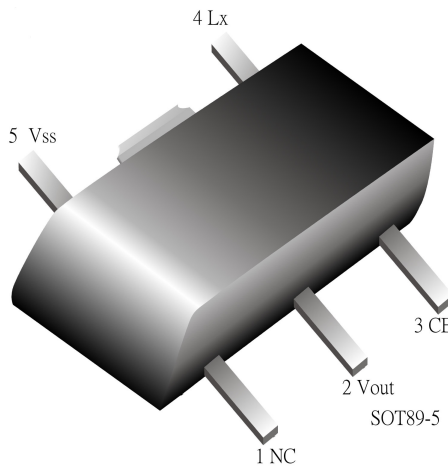
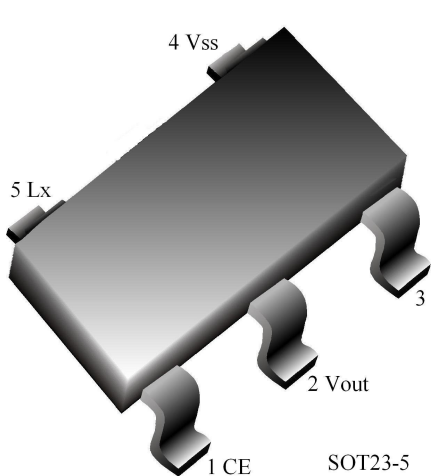


◆ **Typical Applications**



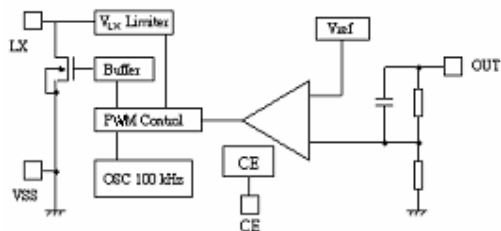
❖ **ML65C**

◆ **Pin Configuration**

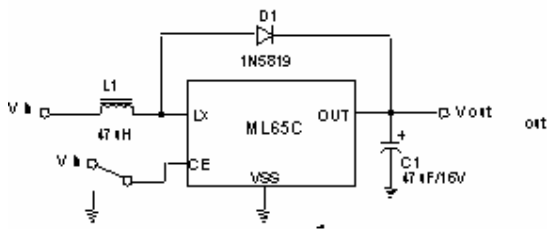


| Package Pin Number | | Pin Name | Function |
|--------------------|---------|------------------|--|
| SOT23-5 | SOT89-5 | | |
| 4 | 5 | V _{SS} | Ground |
| 2 | 2 | V _{OUT} | Output Voltage monitor, Internal IC Power Supply |
| 5 | 4 | LX | Switch |
| 1 | 3 | CE | Chip Enable |
| 3 | 1 | NC | NC |

◆ **Block Diagram**



◆ **Typical Applications**



❖ Absolute Maximum Ratings

| Parameter | Symbol | Ratings | Units | |
|------------------------------------|-----------|------------------------|-------|----|
| Input Voltage | V_{IN} | 10 | V | |
| V_{DD} Input Voltage | V_{DD} | 10 | V | |
| Lx Pin Voltage | V_{LX} | 10 | V | |
| EXT Pin Voltage | V_{EXT} | -0.3 ~ $V_{OUT} + 0.3$ | V | |
| CE Pin Voltage | V_{CE} | -0.3 ~ $V_{OUT} + 0.3$ | V | |
| Lx Pin Current | I_{LX} | 600 | mA | |
| EXT Pin Current | I_{EXT} | ± 30 | mA | |
| Continuous Total Power Dissipation | SOT-89 | Pd | 500 | mW |
| | TO-92 | | 300 | |
| | SOT-23 | | 150 | |
| Operating Ambient Temperature | T_{opr} | -25 ~ +85 | °C | |
| Storage Temperature | T_{stg} | -40 ~ +125 | °C | |

❖ Electrical Characteristics

$V_{IN} = V_{OUT} * 0.6$, $V_{SS} = 0V$, $I_{OUT} = 10mA$, $T_a = 25^\circ C$, unless otherwise specified.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-----------------------|--------------|---|-------------------|-----------|-------------------|-------|
| Output Voltage | V_{OUT} | | $V_{out} * 0.975$ | V_{out} | $V_{out} * 1.025$ | V |
| Input Voltage | V_{IN} | | | | 8 | V |
| Startup Voltage | V_{START} | $I_{OUT} = 1mA$, $V_{IN}: 0 \rightarrow 2V$ | | 0.8 | 0.9 | V |
| Hold-on Voltage | V_{HOLD} | $I_{OUT} = 1mA$, $V_{IN}: 2 \rightarrow 0V$ | 0.7 | | | V |
| Supply Current 1 | I_{DD1} | No external component, $V_{IN} = V_{OUT} * 0.95$ | | 30~70 | | uA |
| Supply Current 2 | I_{DD2} | $V_{IN} = V_{IN} + 0.5V$ | | 11~26 | | uA |
| Lx Switching Current | I_{LX} | $V_{LX} = 0.4V$, $V_{IN} = V_{OUT} * 0.95$ | | 250 | | mA |
| Lx Leakage Current | I_{LXLEAK} | $V_{IN} = V_{LX} = 6.0V$ | | | 0.5 | uA |
| EXT "High" On Current | I_{EXTH} | No external component, $V_{IN} = V_{OUT} * 0.95$, $V_{EXT} = V_{OUT} - 0.4V$ | | -5.5 | | mA |
| EXT "Low" On Current | I_{EXTL} | No external component, $V_{IN} = V_{OUT} * 0.95$, $V_{EXT} = 0.4V$ | | 13 | | mA |
| CE "High" Voltage | V_{CEH} | $V_{IN} = V_{OUT} * 0.95$ | 0.7 | | | V |
| CE "Low" Voltage | V_{CEL} | $V_{IN} = V_{OUT} * 0.95$ | | | 0.2 | V |
| CE "High" Current | I_{CEH} | $V_{OUT} = 6.0V$, $V_{CE} = 6.0V$ | | | 0.25 | uA |
| CE "Low" Current | I_{CEL} | $V_{OUT} = 6.0V$, $V_{CE} = 0.0V$ | | | -0.25 | uA |
| Oscillator Frequency | F_{OSC} | | | 100 | | KHz |
| Duty Cycle | MAXDTY | | 80 | 87 | 92 | % |
| Efficiency | EFF | | | 85 | | % |
| Slow-Start Time | T_{SS} | | 5 | 15 | 25 | ms |

Note : 1. Schokkty diode: 1N5817 or 1N5819 (forward voltage drop : 0.2V)

2. Inductor : 47uH (ESR < 0.5Ω)

3. Capacitor : Tantalum type, 47 uF

❖ Electrical Characteristics
ML65A30 $V_{OUT} = 3.0V$ $V_{IN} = 1.8V$, $I_{OUT} = 10mA$, $T_a = 25^{\circ}C$, unless otherwise provided.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-----------------------|--------------|------------------------------------|-------|-------|-------|---------|
| Output Voltage | V_{OUT} | | 2.925 | 3.000 | 3.075 | V |
| Input Voltage | V_{IN} | | | | 8 | V |
| Startup Voltage | V_{START} | $I_{OUT} = 1mA$ | | 0.8 | 0.9 | V |
| Hold-on Voltage | V_{HOLD} | $I_{OUT} = 1mA$ | 0.7 | | | V |
| Supply Current 1 | I_{DD1} | $V_{IN} = 2.85V$ | | 30 | | μA |
| Supply Current 2 | I_{DD2} | $V_{IN} = 3.05V$ | | 11 | | μA |
| Lx Switching Current | I_{LX} | $V_{LX} = 0.4V$, $V_{IN} = 2.85V$ | | 250 | | mA |
| Lx Leakage Current | I_{LXLEAK} | $V_{IN} = 6.0V$, $V_{LX} = 6.0V$ | | | 0.5 | μA |
| Oscillator Frequency | F_{OSC} | | | 100 | 150 | KHz |
| Oscillator Duty Cycle | MAXDTY | | 80 | 87 | 92 | % |
| Efficiency | EFF | | | 85 | | % |
| Slow –Start Time | T_{SS} | | 5 | 15 | 25 | ms |

ML65A33 $V_{OUT} = 3.3V$ $V_{IN} = 2.0V$, $I_{OUT} = 10mA$, $T_a = 25^{\circ}C$, unless otherwise provided.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-----------------------|--------------|-------------------------------------|-------|-------|-------|---------|
| Output Voltage | V_{OUT} | | 3.218 | 3.300 | 3.383 | V |
| Input Voltage | V_{IN} | | | | 8 | V |
| Startup Voltage | V_{START} | $I_{OUT} = 1mA$ | | 0.8 | 0.9 | V |
| Hold-on Voltage | V_{HOLD} | $I_{OUT} = 1mA$ | 0.7 | | | V |
| Supply Current 1 | I_{DD1} | $V_{IN} = 3.135V$ | | 33 | | μA |
| Supply Current 2 | I_{DD2} | $V_{IN} = 3.35V$ | | 12 | | μA |
| Lx Switching Current | I_{LX} | $V_{LX} = 0.4V$, $V_{IN} = 3.135V$ | | 260 | | mA |
| Lx Leakage Current | I_{LXLEAK} | $V_{IN} = 6.0V$, $V_{LX} = 6.0V$ | | | 0.5 | μA |
| Oscillator Frequency | F_{OSC} | | | 100 | 150 | KHz |
| Oscillator Duty Cycle | MAXDTY | | 80 | 87 | 92 | % |
| Efficiency | EFF | | | 85 | | % |
| Slow –Start Time | T_{SS} | | 5 | 15 | 25 | ms |

ML65A50 $V_{OUT} = 5.0V$ $V_{IN} = 3.0V$, $I_{OUT} = 10mA$, $T_a = 25^{\circ}C$, unless otherwise provided.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-----------------------|--------------|------------------------------------|-------|-------|-------|---------|
| Output Voltage | V_{OUT} | | 4.875 | 5.000 | 5.125 | V |
| Input Voltage | V_{IN} | | | | 8 | V |
| Startup Voltage | V_{START} | $I_{OUT} = 1mA$ | | 0.8 | 0.9 | V |
| Hold-on Voltage | V_{HOLD} | $I_{OUT} = 1mA$ | 0.7 | | | V |
| Supply Current 1 | I_{DD1} | $V_{IN} = 4.75V$ | | 70 | | μA |
| Supply Current 2 | I_{DD2} | $V_{IN} = 5.05V$ | | 26 | | μA |
| Lx Switching Current | I_{LX} | $V_{LX} = 0.4V$, $V_{IN} = 4.75V$ | | 290 | | mA |
| Lx Leakage Current | I_{LXLEAK} | $V_{IN} = 6.0V$, $V_{LX} = 6.0V$ | | | 0.5 | μA |
| Oscillator Frequency | F_{OSC} | | | 100 | 150 | KHz |
| Oscillator Duty Cycle | MAXDTY | | 80 | 87 | 92 | % |
| Efficiency | EFF | | | 85 | | % |
| Slow –Start Time | T_{SS} | | 5 | 15 | 25 | ms |

❖ *Application Notes*

1. It is recommended to use capacitor with a capacity of 10 μ F or more for good frequency characteristics, otherwise it will lead to high output ripple. Tantalum type capacitor is recommended. As there may be the case where a spike-shaped high voltage is generated by the inductor when Lx transistor is turned off, the operating voltage of capacitor should be at least three times of the output set voltage so as to avoid over-voltage damage.
2. It is recommended to use inductor has sufficiently small d.c. resistance, large allowable current and hardly reaches magnetic saturation. When the inductance of inductor is small, there may be the case that the inductor current exceeds the absolute maximum ratings at the maximum load condition.
3. It is recommended to place external components as close as possible to the DC/DC converter so as to minimize the interconnection parasitic between components and DC/DC converter, especially for the capacitor connected to V_{OUT} pin. It is recommended to place 0.1 μ F ceramic capacitor between V_{OUT} pin and V_{SS} pin.
4. It is recommended to provide sufficient grounding for V_{SS} pin. This will help to stable the zero level within DC/DC converter induced by the switching current level variation during operation. And the insufficient grounding may result in unstable operation of DC/DC converter.

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