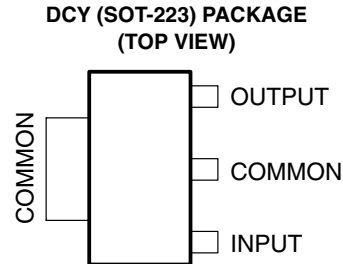
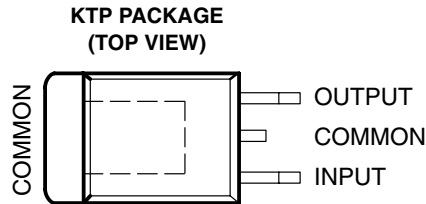


# uA78Mxx-Q1 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS537B – JUNE 2004 – REVISED SEPTEMBER 2008

- Qualified for Automotive Applications
- 3-Terminal Regulators
- Output Current Up To 500 mA
- No External Components
- Internal Thermal-Overload Protection
- High Power-Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Compensation



## description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 500 mA of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents and also as the power-pass element in precision regulators.

## ORDERING INFORMATION<sup>†</sup>

| T <sub>J</sub> | V <sub>O(NOM)</sub><br>(V) | PACKAGE <sup>‡</sup> |              | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|----------------|----------------------------|----------------------|--------------|--------------------------|---------------------|
| -40°C to 125°C | 3.3                        | PowerFLEX™ (KTP)     | Reel of 3000 | UA78M33QKTPRQ1           | 78M33CQ             |
|                |                            | SOT-223 (DCY)        | Reel of 2500 | UA78M33QDCYRQ1           | C3Q                 |
|                | 5                          | PowerFLEX™ (KTP)     | Reel of 3000 | UA78M05QKTPRQ1           | 78M05CQ             |
|                |                            | SOT-223 (DCY)        | Reel of 2500 | UA78M05QDCYRQ1           | C5Q                 |
|                | 8                          | PowerFLEX™ (KTP)     | Reel of 3000 | UA78M08QKTPRQ1           | 78M08CQ             |
|                |                            | SOT-223 (DCY)        | Reel of 2500 | UA78M08QDCYRQ1           | C8Q                 |
|                | 10                         | PowerFLEX™ (KTP)     | Reel of 3000 | UA78M10QKTPRQ1           | 78M10CQ             |

<sup>†</sup> For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

<sup>‡</sup> Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).



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PowerFLEX is a trademark of Texas Instruments.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



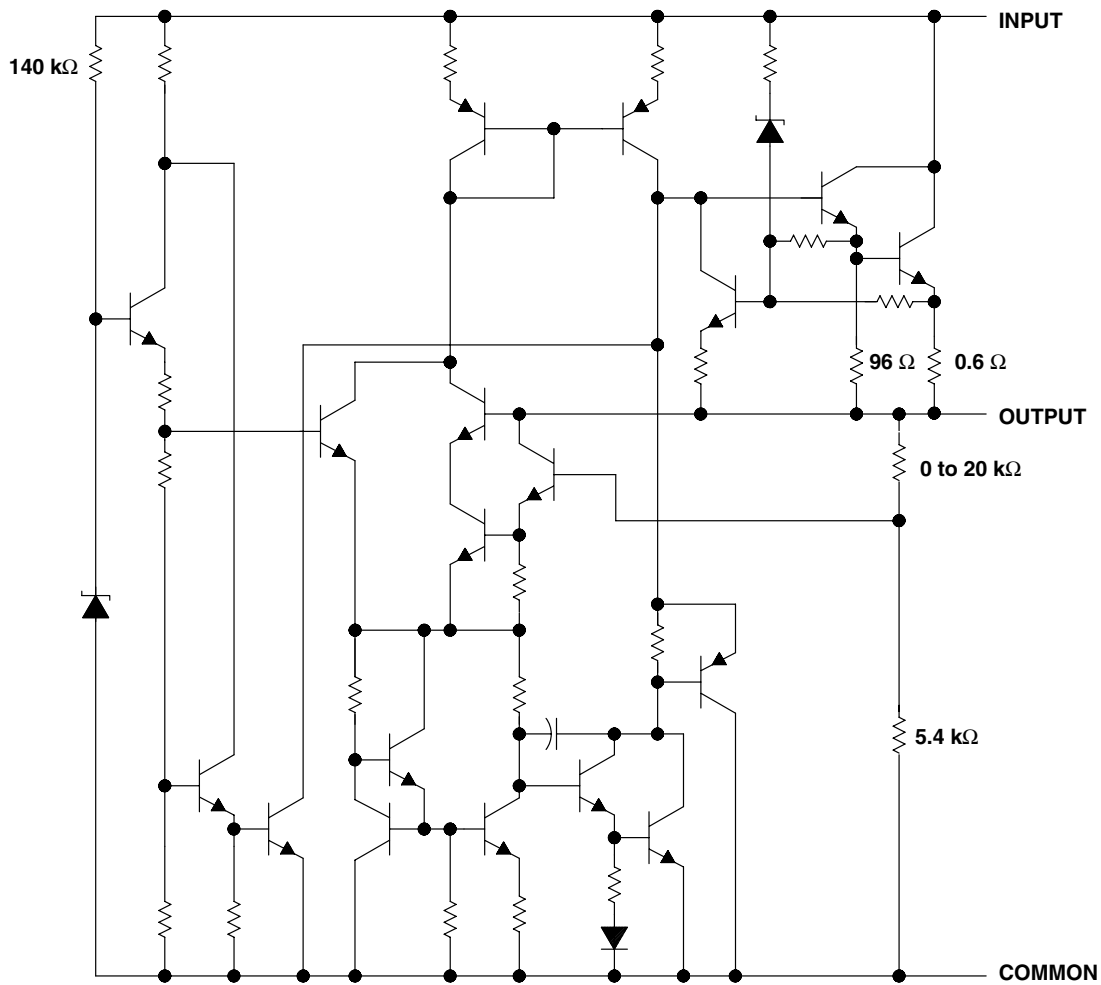
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# uA78Mxx-Q1 SERIES POSITIVE-VOLTAGE REGULATORS

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## schematic



Resistor values shown are nominal.

# **uA78Mxx-Q1 SERIES** **POSITIVE-VOLTAGE REGULATORS**

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## **absolute maximum ratings over virtual junction temperature range (unless otherwise noted)<sup>†</sup>**

|                                                              |                |
|--------------------------------------------------------------|----------------|
| Input voltage, $V_I$                                         | 35 V           |
| Operating virtual junction temperature, $T_J$                | 150°C          |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260°C          |
| Storage temperature range, $T_{stg}$                         | –65°C to 150°C |

<sup>†</sup> Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## **package thermal data (see Note 1)**

| PACKAGE         | BOARD             | $\theta_{JC}$ | $\theta_{JA}$ |
|-----------------|-------------------|---------------|---------------|
| PowerFLEX (KTP) | High K, JESD 51-5 | 19°C/W        | 28°C/W        |
| SOT-223 (DCY)   | High K, JESD 51-7 | 4°C/W         | 53°C/W        |

NOTE 1: Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.

## **recommended operating conditions**

|       |                                        | MIN                | MAX  | UNIT |
|-------|----------------------------------------|--------------------|------|------|
| $V_I$ | Input voltage                          | $\mu\text{A78M33}$ | 5.3  | 25   |
|       |                                        | $\mu\text{A78M05}$ | 7    | 25   |
|       |                                        | $\mu\text{A78M06}$ | 8    | 25   |
|       |                                        | $\mu\text{A78M08}$ | 10.5 | 25   |
|       |                                        | $\mu\text{A78M09}$ | 11.5 | 26   |
|       |                                        | $\mu\text{A78M10}$ | 12.5 | 28   |
|       |                                        | $\mu\text{A78M12}$ | 14.5 | 30   |
| $I_O$ | Output current                         |                    | 500  | mA   |
| $T_J$ | Operating virtual junction temperature | –40                | 125  | °C   |



# **uA78Mxx-Q1 SERIES** **POSITIVE-VOLTAGE REGULATORS**

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**electrical characteristics at specified virtual junction temperature,  $V_I = 8\text{ V}$ ,  $I_O = 350\text{ mA}$ ,  $T_J = 25^\circ\text{C}$  (unless otherwise noted)**

| PARAMETER                                 | TEST CONDITIONS†                                                                                              |                                                                        | $\mu\text{A78M33Q}$ |     |     | UNIT          |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|---------------------|-----|-----|---------------|
|                                           |                                                                                                               |                                                                        | MIN                 | TYP | MAX |               |
| Output voltage‡                           | $I_O = 5\text{ mA to }350\text{ mA}$ ,<br>$V_I = 8\text{ V to }20\text{ V}$                                   |                                                                        | 3.2                 | 3.3 | 3.4 | V             |
|                                           |                                                                                                               | $T_J = -40^\circ\text{C to }125^\circ\text{C}$                         | 3.1                 | 3.3 | 3.5 |               |
| Input voltage regulation                  | $I_O = 200\text{ mA}$                                                                                         | $V_I = 5.3\text{ V to }25\text{ V}$                                    |                     | 9   | 100 | mV            |
|                                           |                                                                                                               | $V_I = 8\text{ V to }25\text{ V}$                                      |                     | 3   | 50  |               |
| Ripple rejection                          | $V_I = 8\text{ V to }18\text{ V}$ ,<br>$f = 120\text{ Hz}$                                                    | $I_O = 100\text{ mA}$ , $T_J = -40^\circ\text{C to }125^\circ\text{C}$ | 62                  |     |     | dB            |
|                                           |                                                                                                               | $I_O = 300\text{ mA}$                                                  | 62                  | 80  |     |               |
| Output voltage regulation                 | $V_I = 8\text{ V}$ , $I_O = 5\text{ mA to }500\text{ mA}$                                                     |                                                                        |                     | 20  | 100 | mV            |
| Temperature coefficient of output voltage | $I_O = 5\text{ mA}$ , $T_J = -40^\circ\text{C to }125^\circ\text{C}$                                          |                                                                        |                     | -1  |     | mV/°C         |
| Output noise voltage                      | $f = 10\text{ Hz to }100\text{ kHz}$                                                                          |                                                                        |                     | 40  | 200 | $\mu\text{V}$ |
| Dropout voltage                           |                                                                                                               |                                                                        |                     | 2   |     | V             |
| Bias current                              |                                                                                                               |                                                                        |                     | 4.5 | 6   | mA            |
| Bias current change                       | $I_O = 200\text{ mA}$ , $V_I = 8\text{ V to }25\text{ V}$ ,<br>$T_J = -40^\circ\text{C to }125^\circ\text{C}$ |                                                                        |                     |     | 0.8 | mA            |
|                                           | $I_O = 5\text{ mA to }350\text{ mA}$ , $T_J = -40^\circ\text{C to }125^\circ\text{C}$                         |                                                                        |                     |     | 0.5 |               |
| Short-circuit output current              | $V_I = 35\text{ V}$                                                                                           |                                                                        |                     | 300 |     | mA            |
| Peak output current                       |                                                                                                               |                                                                        |                     | 700 |     | mA            |

† All characteristics are measured with a 0.33- $\mu\text{F}$  capacitor across the input and a 0.1- $\mu\text{F}$  capacitor across the output. Pulse-testing techniques maintain  $T_J$  as close to  $T_A$  as possible. Thermal effects must be taken into account separately.

‡ This specification applies only for dc power dissipation permitted by absolute maximum ratings.

**electrical characteristics at specified virtual junction temperature,  $V_I = 10\text{ V}$ ,  $I_O = 350\text{ mA}$ ,  $T_J = 25^\circ\text{C}$  (unless otherwise noted)**

| PARAMETER                                 | TEST CONDITIONS†                                                                                              |                                                                        | $\mu\text{A78M05Q}$ |     |      | UNIT          |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|---------------------|-----|------|---------------|
|                                           |                                                                                                               |                                                                        | MIN                 | TYP | MAX  |               |
| Output voltage                            | $I_O = 5\text{ mA to }350\text{ mA}$ ,<br>$V_I = 7\text{ V to }20\text{ V}$                                   |                                                                        | 4.8                 | 5   | 5.2  | V             |
|                                           |                                                                                                               | $T_J = -40^\circ\text{C to }125^\circ\text{C}$                         | 4.75                |     | 5.25 |               |
| Input voltage regulation                  | $I_O = 200\text{ mA}$                                                                                         | $V_I = 7\text{ V to }25\text{ V}$                                      |                     | 3   | 100  | mV            |
|                                           |                                                                                                               | $V_I = 8\text{ V to }25\text{ V}$                                      |                     | 1   | 50   |               |
| Ripple rejection                          | $V_I = 8\text{ V to }18\text{ V}$ ,<br>$f = 120\text{ Hz}$                                                    | $I_O = 100\text{ mA}$ , $T_J = -40^\circ\text{C to }125^\circ\text{C}$ | 62                  |     |      | dB            |
|                                           |                                                                                                               | $I_O = 300\text{ mA}$                                                  | 62                  | 80  |      |               |
| Output voltage regulation                 | $I_O = 5\text{ mA to }500\text{ mA}$                                                                          |                                                                        |                     | 20  | 100  | mV            |
|                                           | $I_O = 5\text{ mA to }200\text{ mA}$                                                                          |                                                                        |                     | 10  | 50   |               |
| Temperature coefficient of output voltage | $I_O = 5\text{ mA}$ , $T_J = -40^\circ\text{C to }125^\circ\text{C}$                                          |                                                                        |                     | -1  |      | mV/°C         |
| Output noise voltage                      | $f = 10\text{ Hz to }100\text{ kHz}$                                                                          |                                                                        |                     | 40  | 200  | $\mu\text{V}$ |
| Dropout voltage                           |                                                                                                               |                                                                        |                     | 2   |      | V             |
| Bias current                              |                                                                                                               |                                                                        |                     | 4.5 | 6    | mA            |
| Bias current change                       | $I_O = 200\text{ mA}$ , $V_I = 8\text{ V to }25\text{ V}$ ,<br>$T_J = -40^\circ\text{C to }125^\circ\text{C}$ |                                                                        |                     |     | 0.8  | mA            |
|                                           | $I_O = 5\text{ mA to }350\text{ mA}$ , $T_J = -40^\circ\text{C to }125^\circ\text{C}$                         |                                                                        |                     |     | 0.5  |               |
| Short-circuit output current              | $V_I = 35\text{ V}$                                                                                           |                                                                        |                     | 300 |      | mA            |
| Peak output current                       |                                                                                                               |                                                                        |                     | 0.7 |      | A             |

† All characteristics are measured with a 0.33- $\mu\text{F}$  capacitor across the input and a 0.1- $\mu\text{F}$  capacitor across the output. Pulse-testing techniques maintain  $T_J$  as close to  $T_A$  as possible. Thermal effects must be taken into account separately.



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# **uA78Mxx-Q1 SERIES** **POSITIVE-VOLTAGE REGULATORS**

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**electrical characteristics at specified virtual junction temperature,  $V_I = 14$  V,  $I_O = 350$  mA,  $T_J = 25^\circ\text{C}$  (unless otherwise noted)**

| PARAMETER                                 | TEST CONDITIONS†                               |                                                                  |  | $\mu\text{A78M08Q}$ |     |     | UNIT                 |
|-------------------------------------------|------------------------------------------------|------------------------------------------------------------------|--|---------------------|-----|-----|----------------------|
|                                           |                                                |                                                                  |  | MIN                 | TYP | MAX |                      |
| Output voltage                            | $V_I = 10.5$ V to 23 V, $I_O = 5$ mA to 350 mA | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  | 7.7                 | 8   | 8.3 | V                    |
|                                           |                                                |                                                                  |  | 7.6                 |     | 8.4 |                      |
| Input voltage regulation                  | $I_O = 200$ mA                                 | $V_I = 10.5$ V to 25 V                                           |  |                     | 6   | 100 | mV                   |
|                                           |                                                | $V_I = 11$ V to 25 V                                             |  |                     | 2   | 50  |                      |
| Ripple rejection                          | $V_I = 11.5$ V to 21.5 V, $f = 120$ Hz         | $I_O = 100$ mA, $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$ |  | 56                  |     |     | dB                   |
|                                           |                                                | $I_O = 300$ mA                                                   |  | 56                  | 80  |     |                      |
| Output voltage regulation                 | $I_O = 5$ mA to 500 mA                         |                                                                  |  |                     | 25  | 160 | mV                   |
|                                           | $I_O = 5$ mA to 200 mA                         |                                                                  |  |                     | 10  | 80  |                      |
| Temperature coefficient of output voltage | $I_O = 5$ mA,                                  | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  |                     | -1  |     | mV/ $^\circ\text{C}$ |
| Output noise voltage                      | $f = 10$ Hz to 100 kHz                         |                                                                  |  |                     | 52  |     | $\mu\text{V}$        |
| Dropout voltage                           |                                                |                                                                  |  |                     | 2   |     | V                    |
| Bias current                              |                                                |                                                                  |  |                     | 4.6 | 6   | mA                   |
| Bias current change                       | $V_I = 10.5$ V to 25 V, $I_O = 200$ mA,        | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  |                     |     | 0.8 | mA                   |
|                                           | $I_O = 5$ mA to 350 mA,                        | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  |                     |     | 0.5 |                      |
| Short-circuit output current              | $V_I = 35$ V                                   |                                                                  |  |                     | 250 |     | mA                   |
| Peak output current                       |                                                |                                                                  |  |                     | 0.7 |     | A                    |

† All characteristics are measured with a 0.33- $\mu\text{F}$  capacitor across the input and a 0.1- $\mu\text{F}$  capacitor across the output. Pulse-testing techniques maintain  $T_J$  as close to  $T_A$  as possible. Thermal effects must be taken into account separately.

**electrical characteristics at specified virtual junction temperature,  $V_I = 17$  V,  $I_O = 350$  mA,  $T_J = 25^\circ\text{C}$  (unless otherwise noted)**

| PARAMETER                                 | TEST CONDITIONS†                               |                                                                  |  | $\mu\text{A78M10Q}$ |     |      | UNIT                 |
|-------------------------------------------|------------------------------------------------|------------------------------------------------------------------|--|---------------------|-----|------|----------------------|
|                                           |                                                |                                                                  |  | MIN                 | TYP | MAX  |                      |
| Output voltage                            | $V_I = 12.5$ V to 25 V, $I_O = 5$ mA to 350 mA | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  | 9.6                 | 10  | 10.4 | V                    |
|                                           |                                                |                                                                  |  | 9.5                 |     | 10.5 |                      |
| Input voltage regulation                  | $I_O = 200$ mA                                 | $V_I = 12.5$ V to 28 V                                           |  |                     | 7   | 100  | mV                   |
|                                           |                                                | $V_I = 14$ V to 28 V                                             |  |                     | 2   | 50   |                      |
| Ripple rejection                          | $V_I = 15$ V to 25 V, $f = 120$ Hz             | $I_O = 100$ mA, $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$ |  | 59                  |     |      | dB                   |
|                                           |                                                | $I_O = 300$ mA                                                   |  | 55                  | 80  |      |                      |
| Output voltage regulation                 | $I_O = 5$ mA to 500 mA                         |                                                                  |  |                     | 25  | 200  | mV                   |
|                                           | $I_O = 5$ mA to 200 mA                         |                                                                  |  |                     | 10  | 100  |                      |
| Temperature coefficient of output voltage | $I_O = 5$ mA,                                  | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  |                     | -1  |      | mV/ $^\circ\text{C}$ |
| Output noise voltage                      | $f = 10$ Hz to 100 kHz                         |                                                                  |  |                     | 64  |      | $\mu\text{V}$        |
| Dropout voltage                           |                                                |                                                                  |  |                     | 2   |      | V                    |
| Bias current                              |                                                |                                                                  |  |                     | 4.7 | 6    | mA                   |
| Bias current change                       | $V_I = 12.5$ V to 28 V, $I_O = 200$ mA,        | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  |                     |     | 0.8  | mA                   |
|                                           | $I_O = 5$ mA to 350 mA,                        | $T_J = -40^\circ\text{C}$ to $125^\circ\text{C}$                 |  |                     |     | 0.5  |                      |
| Short-circuit output current              | $V_I = 35$ V                                   |                                                                  |  |                     | 245 |      | mA                   |
| Peak output current                       |                                                |                                                                  |  |                     | 0.7 |      | A                    |

† All characteristics are measured with a 0.33- $\mu\text{F}$  capacitor across the input and a 0.1- $\mu\text{F}$  capacitor across the output. Pulse-testing techniques maintain  $T_J$  as close to  $T_A$  as possible. Thermal effects must be taken into account separately.



## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| UA78M05QDCYRG4Q1 | ACTIVE        | SOT-223      | DCY                | 4    | 2500           | Green (RoHS<br>& no Sb/Br) | NIPDAU                  | Level-2-260C-1 YEAR  | -40 to 125   | C5Q                     | <a href="#">Samples</a> |
| UA78M05QDCYRQ1   | ACTIVE        | SOT-223      | DCY                | 4    | 2500           | Green (RoHS<br>& no Sb/Br) | NIPDAU                  | Level-2-260C-1 YEAR  | -40 to 125   | C5Q                     | <a href="#">Samples</a> |
| UA78M33QDCYRG4Q1 | ACTIVE        | SOT-223      | DCY                | 4    | 2500           | Green (RoHS<br>& no Sb/Br) | NIPDAU                  | Level-2-260C-1 YEAR  | -40 to 125   | C3Q                     | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**OTHER QUALIFIED VERSIONS OF UA78M-Q1 :**

- Catalog: [UA78M](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| UA78M05QDCYRG4Q1 | SOT-223      | DCY             | 4    | 2500 | 330.0              | 12.4               | 6.8     | 7.3     | 1.88    | 8.0     | 12.0   | Q3            |
| UA78M33QDCYRG4Q1 | SOT-223      | DCY             | 4    | 2500 | 330.0              | 12.4               | 6.83    | 7.42    | 1.88    | 8.0     | 12.0   | Q3            |

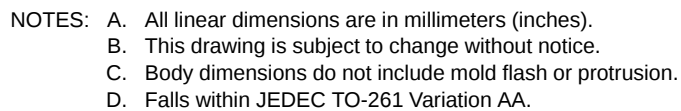
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

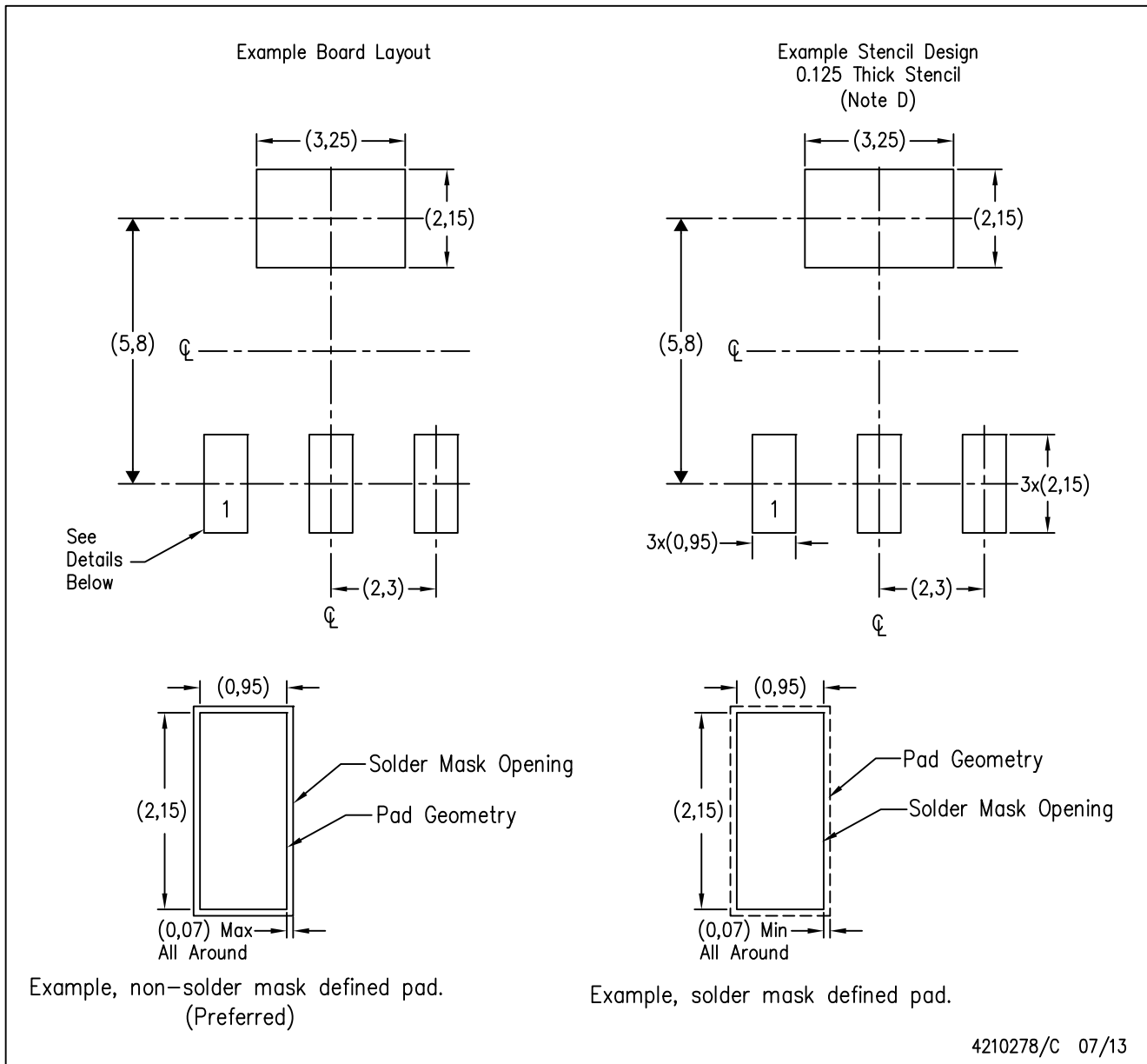
| Device           | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| UA78M05QDCYRG4Q1 | SOT-223      | DCY             | 4    | 2500 | 346.0       | 346.0      | 29.0        |
| UA78M33QDCYRG4Q1 | SOT-223      | DCY             | 4    | 2500 | 346.0       | 346.0      | 29.0        |

## PLASTIC SMALL-OUTLINE



DCY (R-PDSO-G4)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil recommendations. Refer to IPC 7525 for stencil design considerations.

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