CL2

Simple 90V, 20mA, Temperature Compensated, Constant-Current LED Driver IC

Features
• 5.0 to 90V operating range (VA-B)
• 20 mA ±10% at 5.0 - 90V
• 0.01%/°C typical temperature coefficient
• Available in TO-243AA (SOT-89), TO-252(D-PAK), & TO-92 packages
• Can be paralleled for higher current

Applications
• LED driver
• Industrial lamp indicators
• Signage
• Accent lighting
• Automotive
• Constant current source
• Constant current sink

Description
CL2 is a high voltage, temperature compensated, constant-current source. The device is trimmed to provide a constant current of 20 mA ±10% at an input voltage of 5–90V. The device can be used as a two-terminal, constant-current source or constant-current sink.

A typical application for the CL2 is to drive LEDs with a constant current of 20 mA. Multiple CL2s can also be used in parallel to provide higher currents such as 40 mA, 60 mA or 80 mA. The device is available in TO-243AA (SOT-89), TO-252 (D-PAK), and TO-92 packages.

Package Type

See Table 2-1 for pin information
Typical Application Circuit

Up to 90V
+ \( V_{\text{LED(total)}} \)

100nF

\( I_{\text{LED}} < 20\text{mA} \)

\( V_{\text{LED(total)}} \)

Control Circuit and Temperature Compensation

CL2
1.0 ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS†

Operating voltage, \( V_{A-B} \) .................................................................................................................. 100V
Operating junction temperature, \( T_j \) .................................................................................................. -40 to +125 °C
Storage Temperature, \( T_s \) .................................................................................................................. -55 to +150 °C

† Notice: Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC AND AC CHARACTERISTICS

Electrical Specifications: Unless otherwise specified, for all specifications \( T_A = +25°C \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage</td>
<td>( V_{A-B} )</td>
<td>5.0</td>
<td>-</td>
<td>90</td>
<td>V</td>
<td>---</td>
</tr>
<tr>
<td>Current regulation</td>
<td>( I_{A-B} )</td>
<td>18.0</td>
<td>20</td>
<td>22</td>
<td>mA</td>
<td>( V_{A-B} = 5.0V - 90V )</td>
</tr>
<tr>
<td>( I_{A-B} ) temperature coefficient</td>
<td>( \Delta I_{A-B}/\Delta T )</td>
<td>-</td>
<td>0.01</td>
<td>-</td>
<td>%/°C</td>
<td>( V_{A-B} = 45V, T_j = -40°C to +100°C )</td>
</tr>
<tr>
<td>Operating junction temperature</td>
<td>( T_j )</td>
<td>-40</td>
<td>-</td>
<td>125</td>
<td>°C</td>
<td>---</td>
</tr>
<tr>
<td>Dynamic resistance</td>
<td>( R_{A-B} )</td>
<td>-</td>
<td>300</td>
<td>-</td>
<td>kΩ</td>
<td>---</td>
</tr>
</tbody>
</table>

TEMPERATURE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Ranges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Junction Temperature</td>
<td>( T_j )</td>
<td>-40</td>
<td>-</td>
<td>125</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>( T_s )</td>
<td>-55</td>
<td>-</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Package Thermal Resistances</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal Resistance, TO-92</td>
<td>( \theta_{ja} )</td>
<td>-</td>
<td>132</td>
<td>-</td>
<td>°C/W</td>
<td></td>
</tr>
<tr>
<td>Thermal Resistance, TO-252</td>
<td>( \theta_{ja} )</td>
<td>-</td>
<td>81</td>
<td>-</td>
<td>°C/W</td>
<td>Note 1</td>
</tr>
<tr>
<td>Thermal Resistance, TO-243AA</td>
<td>( \theta_{ja} )</td>
<td>-</td>
<td>133</td>
<td>-</td>
<td>°C/W</td>
<td>Note 1</td>
</tr>
</tbody>
</table>

Note 1: Mounted on FR4 board, 25mm x 25mm x 1.57 mm

TABLE 1-1: THERMAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Package</th>
<th>Power Dissipation @( T_A = 2.5°C ) (W)</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO-92</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>TO-252</td>
<td>2.0</td>
<td>Note 1</td>
</tr>
<tr>
<td>TO-243AA</td>
<td>1.3</td>
<td>Note 1</td>
</tr>
</tbody>
</table>

Note 1: Mounted on FR4 board, 25mm x 25mm x 1.57 mm
2.0 PIN DESCRIPTION

The locations of the pins are listed in Package Type and Packaging Information.

**TABLE 2-1: PIN DESCRIPTION**

<table>
<thead>
<tr>
<th>Pin # TO-92</th>
<th>Pin # TO-252</th>
<th>Pin # To-243AA</th>
<th>Symbol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>VA</td>
<td>Current in</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>NC</td>
<td>No connect</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>2,4</td>
<td>VB</td>
<td>Current out</td>
</tr>
</tbody>
</table>
3.0 FUNCTIONAL DESCRIPTION

Figure 3-1 provides the Functional Circuit diagram and its equivalent block diagram for CL2. Performance information is available in Figure 3-2 and Figure 3-3. Figure 3-4 and Figure 3-5 provide example schematics.

**FIGURE 3-1:** Functional Circuit Diagram and Equivalent Block Diagram

**FIGURE 3-2:** Temperature Characteristics
FIGURE 3-3: Output Current vs Voltage

FIGURE 3-4: CL2 for Multiple LED Strings
FIGURE 3-5: CL2 for Higher Current

Up to 90V

\[ +V_{\text{LED}(\text{total})} \]

100nF

\[ \text{CL2} \]

\[ \text{CL2} \]

\[ \text{CL2} \]

\[ I_{\text{LED}} \approx 60\text{mA} \]

\[ V_{\text{LED}(\text{total})} \]
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

Legend:
- XX...X  Product Code or Customer-specific information
- Y  Year code (last digit of calendar year)
- YY  Year code (last 2 digits of calendar year)
- WW  Week code (week of January 1 is week '01')
- NNN  Alphanumeric traceability code
- \(^{\circ}\)  Pb-free JEDEC\textsuperscript{®} designator for Matte Tin (Sn)
- *  This package is Pb-free. The Pb-free JEDEC designator \((\circ\)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.
3-Lead TO-92 Package Outline (L/LL/N3)

Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>A</th>
<th>b</th>
<th>c</th>
<th>D</th>
<th>E</th>
<th>E1</th>
<th>e</th>
<th>e1</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN</td>
<td>.170</td>
<td>.014\text{f}</td>
<td>.014\text{f}</td>
<td>.175</td>
<td>.125</td>
<td>.080</td>
<td>.095</td>
<td>.045</td>
<td>.500</td>
</tr>
<tr>
<td>NOM</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MAX</td>
<td>.210</td>
<td>.022\text{f}</td>
<td>.022\text{f}</td>
<td>.205</td>
<td>.165</td>
<td>.105</td>
<td>.105</td>
<td>.055</td>
<td>.610*</td>
</tr>
</tbody>
</table>

JEDEC Registration TO-92.
* This dimension is not specified in the JEDEC drawing.
† This dimension differs from the JEDEC drawing.

Drawings not to scale.
3-Lead TO-252 (D-PAK) Package Outline (K4)

Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Note:
1. Although 4 terminal locations are shown, only 3 are functional. Lead number 2 was removed.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>A</th>
<th>A1</th>
<th>b</th>
<th>b2</th>
<th>b3</th>
<th>c2</th>
<th>D</th>
<th>D1</th>
<th>E</th>
<th>E1</th>
<th>e</th>
<th>H</th>
<th>L</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>L4</th>
<th>L5</th>
<th>θ</th>
<th>φ</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN</td>
<td>.066</td>
<td>.000*</td>
<td>.025</td>
<td>.030</td>
<td>.195</td>
<td>.018</td>
<td>.235</td>
<td>.265</td>
<td>.250</td>
<td>.170</td>
<td>.090</td>
<td>.065</td>
<td>.085</td>
<td>.025</td>
<td>.005</td>
<td>.005</td>
<td>.045</td>
<td>.215</td>
<td>.095</td>
<td>.245</td>
</tr>
<tr>
<td>NOM</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.240</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.090</td>
<td>.065</td>
<td>.108</td>
<td>REF</td>
<td>.020</td>
<td>BSC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MAX</td>
<td>.094</td>
<td>.005</td>
<td>.035</td>
<td>.045</td>
<td>.215</td>
<td>.095</td>
<td>.245</td>
<td>.217*</td>
<td>.265</td>
<td>.200*</td>
<td>.410</td>
<td>.070</td>
<td>.090</td>
<td>.040</td>
<td>.060</td>
<td>10°</td>
<td>15°</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* This dimension is not specified in the JEDEC drawing.
† This dimension differs from the JEDEC drawing.
Drawings not to scale.
3-Lead TO-243AA (SOT-89) Package Outline (N8)

Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com-packaging.
APPENDIX A: REVISION HISTORY

Revision A (November 2015)

• Updated file to Microchip format
PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>Device</th>
<th>Package</th>
<th>Environmental</th>
<th>Media Type</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>XX-XX-XX</td>
<td>CL2</td>
<td>N3</td>
<td>G</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>K4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(blank)</td>
<td></td>
<td></td>
<td>P002</td>
</tr>
</tbody>
</table>

Device: CL2 = Simple 90V, 20 mA, Temperature-Compensated, Constant-Current LED Driver IC

Package: N3 = TO-92, 3-lead
K4 = TO-252 (D-PAK), 3-lead
N8 = TO-243AA (SOT-89), 3-lead

Environmental: G = Lead (Pb)-free/ROHS-compliant package

Media Type:
- (blank) = 1000/Bag for N3 packages
- = 2000/Reel for K4 packages
- = 2000/Reel for N8 packages
- P002 = 2000/Reel for N3

Examples:

a) CL2N3-G TO-92 package, 1000/Bag
b) CL2K4-G TO-252 package, 2000/Reel
c) CL2N8-G TO-243AA package, 2000/Reel
d) CL2N3-G-P002 TO-92 package, 2000/Reel
Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip’s Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip’s code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer’s risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, flexPWR, JukeBlox, KEELOQ, KEELOQ logo, Kleer, LANCheck, MediaLB, MOST, MOST logo, MPLAB, OptoLyzer, PIC, PICSTART, PIC32 logo, RightTouch, SpyNIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

The Embedded Control Solutions Company and mTouch are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, ECAN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, KleerNet, KleerNet logo, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscent Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, RightTouch logo, REAL ICE, SQI, Serial Quad I/O, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2015, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-0014-1

QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV

ISO/TS 16949

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company’s quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KeelLoq® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip’s quality system for the design and manufacture of development systems is ISO 9001:2000 certified.
### Worldwide Sales and Service

#### AMERICAS
- **Corporate Office**
  - 2355 West Chandler Blvd.
  - Chandler, AZ 85224-6199
  - Tel: 480-792-7200
  - Fax: 480-792-7277
  - Technical Support: [http://www.microchip.com/support](http://www.microchip.com/support)
  - Web Address: [www.microchip.com](http://www.microchip.com)
- **Atlanta**
  - Duluth, GA
  - Tel: 678-957-9614
  - Fax: 678-957-1455
- **Austin, TX**
  - Tel: 512-257-3370
- **Boston**
  - Westborough, MA
  - Tel: 774-760-0087
  - Fax: 774-760-0088
- **Chicago**
  - Itasca, IL
  - Tel: 630-285-0071
  - Fax: 630-285-0075
- **Cleveland**
  - Independence, OH
  - Tel: 216-447-0464
  - Fax: 216-447-0643
- **Dallas**
  - Addison, TX
  - Tel: 972-818-7423
  - Fax: 972-818-2924
- **Detroit**
  - Novi, MI
  - Tel: 248-848-4000
- **Houston, TX**
  - Tel: 281-894-5983
- **Indianapolis**
  - Noblesville, IN
  - Tel: 317-773-8323
  - Fax: 317-773-5453
- **Los Angeles**
  - Mission Viejo, CA
  - Tel: 949-462-9523
  - Fax: 949-462-9608
- **New York, NY**
  - Tel: 631-435-6000
- **San Jose, CA**
  - Tel: 408-735-9110
- **Canada - Toronto**
  - Tel: 905-673-0699
  - Fax: 905-673-6509

#### ASIA/PACIFIC
- **Asia Pacific Office**
  - Suites 3707-14, 37th Floor
  - Tower 6, The Gateway Harbour City, Kowloon
- **Hong Kong**
  - Tel: 852-2943-5100
  - Fax: 852-2401-3431
- **Australia - Sydney**
  - Tel: 61-2-9868-6733
  - Fax: 61-2-9868-6755
- **China - Beijing**
  - Tel: 86-10-8569-7000
  - Fax: 86-10-8528-2104
- **China - Chengdu**
  - Tel: 86-28-8665-5511
  - Fax: 86-28-8665-7889
- **China - Chongqing**
  - Tel: 86-23-8980-9588
  - Fax: 86-23-8980-9500
- **China - Dongguan**
  - Tel: 86-769-8702-9880
  - Fax: 86-769-8702-9880
- **China - Hangzhou**
  - Tel: 86-571-8792-8115
  - Fax: 86-571-8792-8116
- **China - Hong Kong SAR**
  - Tel: 852-2943-5100
  - Fax: 852-2401-3431
- **China - Nanjing**
  - Tel: 86-25-8473-2460
  - Fax: 86-25-8473-2470
- **China - Qingdao**
  - Tel: 86-532-8502-7355
  - Fax: 86-532-8502-7205
- **China - Shanghai**
  - Tel: 86-21-5407-5533
  - Fax: 86-21-5407-5066
- **China - Shenyang**
  - Tel: 86-24-2334-2829
  - Fax: 86-24-2334-2393
- **China - Shenzhen**
  - Tel: 86-755-8864-2200
  - Fax: 86-755-8203-1760
- **China - Wuhan**
  - Tel: 86-27-5980-5300
  - Fax: 86-27-5980-5118
- **China - Xian**
  - Tel: 86-29-8833-7252
  - Fax: 86-29-8833-7256
- **China - Xiamen**
  - Tel: 86-592-2388138
  - Fax: 86-592-2388130
- **China - Zhuhai**
  - Tel: 86-756-3210040
  - Fax: 86-756-3210049
- **India - Bangalore**
  - Tel: 91-80-3090-4444
  - Fax: 91-80-3090-4123
- **India - New Delhi**
  - Tel: 91-11-4160-8631
  - Fax: 91-11-4160-8632
- **India - Pune**
  - Tel: 91-20-3019-1500
- **Japan - Osaka**
  - Tel: 81-6-6152-7160
  - Fax: 81-6-6152-9310
- **Japan - Tokyo**
  - Tel: 81-3-6880-3770
  - Fax: 81-3-6880-3771
- **Korea - Daegu**
  - Tel: 82-53-744-4301
  - Fax: 82-53-744-4302
- **Korea - Seoul**
  - Tel: 82-2-554-7200
  - Fax: 82-2-558-5932 or 82-2-558-5934
- **Malaysia - Kuala Lumpur**
  - Tel: 60-3-6201-9857
  - Fax: 60-3-6201-9859
- **Malaysia - Penang**
  - Tel: 60-4-227-8870
  - Fax: 60-4-227-4068
- **Philippines - Manila**
  - Tel: 63-2-634-9065
  - Fax: 63-2-634-9069
- **Singapore**
  - Tel: 65-6334-8870
  - Fax: 65-6334-8850
- **Taiwan - Hsin Chu**
  - Tel: 886-3-5778-366
  - Fax: 886-3-5770-955
- **Taiwan - Kaohsiung**
  - Tel: 886-7-213-7828
- **Taiwan - Taipei**
  - Tel: 886-2-2508-8600
  - Fax: 886-2-2508-0102
- **Thailand - Bangkok**
  - Tel: 66-2-694-1351
  - Fax: 66-2-694-1350

#### EUROPE
- **Austria - Wels**
  - Tel: 43-7242-2244-39
  - Fax: 43-7242-2244-393
- **Denmark - Copenhagen**
  - Tel: 45-4450-2828
  - Fax: 45-4485-2829
- **France - Paris**
  - Tel: 33-1-69-53-63-20
  - Fax: 33-1-69-30-90-79
- **Germany - Dusseldorf**
  - Tel: 49-2129-3766400
- **Germany - Karlsruhe**
  - Tel: 49-721-625370
- **Germany - Munich**
  - Tel: 49-89-627-144-0
  - Fax: 49-89-627-144-44
- **Italy - Milan**
  - Tel: 39-0331-742611
  - Fax: 39-0331-466781
- **Italy - Venice**
  - Tel: 39-049-7625286
- **Netherlands - Drunen**
  - Tel: 31-416-690399
  - Fax: 31-416-690340
- **Poland - Warsaw**
  - Tel: 48-22-3325737
- **Spain - Madrid**
  - Tel: 34-91-708-08-90
  - Fax: 34-91-708-08-91
- **Sweden - Stockholm**
  - Tel: 46-8-5090-4654
- **UK - Wokingham**
  - Tel: 44-118-921-5800
  - Fax: 44-118-921-5820

© 2015 Microchip Technology Inc.

07/14/15