

# DUAL ISOLATED DC/DC CONVERTER

## FEATURES

- **DUAL ISOLATED  $\pm 5V$  TO  $\pm 16V$  OUTPUTS**
- **HIGH BREAKDOWN VOLTAGE: 8000V Test**
- **LOW LEAKAGE CURRENT:**  
 $< 1\mu A$  at 240V/60Hz
- **LOW COST PER ISOLATED CHANNEL**
- **SMALL SIZE: 27.9mm x 27.9mm x 7.6mm**  
(1.1" x 1.1" x 0.3")

## APPLICATIONS

- **MEDICAL EQUIPMENT**
- **INDUSTRIAL PROCESS CONTROL**
- **TEST EQUIPMENT**
- **DATA ACQUISITION SYSTEMS**
- **NUCLEAR INSTRUMENTATION**

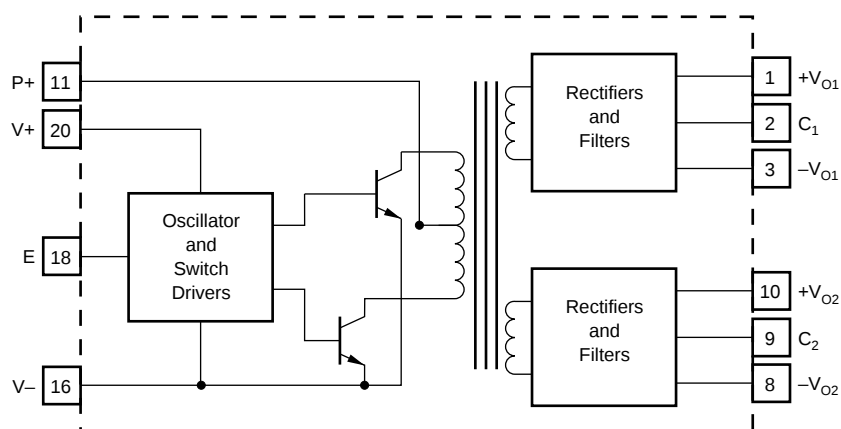
## DESCRIPTION

The 722 converts a single  $5V_{DC}$  to  $16V_{DC}$  input into a pair of bipolar output voltages of the same value as the input voltage. The converter is capable of providing a total output current of 64mA at rated voltage accuracy and up to 200mA without damage.

The two output channels are isolated from the input and from each other. They may be connected independently, in series for higher output voltage or in parallel for higher output current, as a single channel isolated DC/DC converter.

Integrated circuit construction of the 722 reduces size and cost. High isolation breakdown voltages and low leakage currents are assured by special design and construction that includes use of a high dielectric strength, low leakage coating used on the internal assembly.

A self-contained 900kHz oscillator drives switching circuitry, which is designed to eliminate the common problem of input current spiking due to transformer saturation or crossover switching.



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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.

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

|                                |                 |
|--------------------------------|-----------------|
| Supply Voltage, V+ to V- ..... | 16V             |
| Input Current .....            | 275mA           |
| Operating Temperature .....    | -25°C to +80°C  |
| Storage Temperature .....      | -55°C to +125°C |
| Junction Temperature .....     | -55°C to +125°C |

NOTE: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.



## ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## PACKAGE/ORDERING INFORMATION<sup>(1)</sup>

| PRODUCT | PACKAGE-LEAD | PACKAGE DESIGNATOR | SPECIFIED TEMPERATURE RANGE <sup>(2)</sup> | PACKAGE MARKING | ORDERING NUMBER | TRANSPORT MEDIA, QUANTITY |
|---------|--------------|--------------------|--------------------------------------------|-----------------|-----------------|---------------------------|
| 722     | DIP-20       | JND                | -25°C to +85°C                             | 722             | 722G            | Rails, 17                 |
| 722BG   | DIP-20       | JND                | -25°C to +85°C                             | 722BG           | 722BG           | Rails, 17                 |
| 722MG   | DIP-20       | JND                | -25°C to +85°C                             | 722MG           | 722MG           | Rails, 17                 |

NOTES: (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com). (2) -25°C to +60°C for  $16\text{mA} \leq I_{\text{LOAD}} \leq 40\text{mA}$  per output.

# ELECTRICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_{IN} = 15\text{VDC}$ ,  $C = 0.47\mu\text{F}$ , and  $R_1$  selected per typical characteristic, unless otherwise noted.

| PARAMETER                              | CONDITIONS                                               | 722     |       |      | 722BG |      |      | 722MG |     |      | UNITS    |
|----------------------------------------|----------------------------------------------------------|---------|-------|------|-------|------|------|-------|-----|------|----------|
|                                        |                                                          | MIN     | TYP   | MAX  | MIN   | TYP  | MAX  | MIN   | TYP | MAX  |          |
| <b>INPUT</b>                           |                                                          |         |       |      |       |      |      |       |     |      |          |
| Rated Input Voltage                    |                                                          |         | 15    |      | *     | *    |      | *     | *   |      | VDC      |
| Input Voltage Range <sup>(1)</sup>     |                                                          | 5       |       | 16   | *     |      | *    | *     |     | *    | VDC      |
| Input Current                          | Total Output Current = 12mA                              |         | 50    |      |       | *    |      |       | *   |      | mA       |
|                                        | Total Output Current = 64mA                              |         | 105   | 120  |       | *    | *    |       | *   | *    | mA       |
|                                        | Total Output Current = 64mA at $T_A = +85^\circ\text{C}$ |         | 120   |      |       | *    |      |       | *   |      | mA       |
| Input Ripple <sup>(2)</sup>            | Total Output Current = 160mA                             |         | —     | —    |       | 225  | 275  |       | —   | —    | mA       |
|                                        | Total Output Current = 12mA                              |         | 3     |      |       | *    |      |       | *   |      | mA, pk   |
|                                        | Total Output Current = 64mA                              |         | 6     |      |       | *    |      |       | *   |      | mA, pk   |
|                                        | Total Output Current = 160mA                             |         | —     |      |       | 12   |      |       | —   |      | mA, pk   |
| <b>ISOLATION</b>                       |                                                          |         |       |      |       |      |      |       |     |      |          |
| Test Voltages                          | Input-to-Output, 5 seconds, min                          |         |       | 8000 |       |      | *    |       |     | *    | Vpk      |
|                                        | Input-to-Output, 1 minute, min                           |         |       | —    |       |      | —    |       |     | 2500 | Vrms     |
| Rated Voltages                         | Channel-to-Channel, 5 seconds, min                       |         |       | 5000 |       |      | *    |       |     | *    | Vpk      |
|                                        | Input-to-Output, continuous                              |         |       | 3500 |       |      | *    |       |     | *    | V        |
| Isolation Impedance                    | Channel-to-Channel, continuous                           |         |       | 2000 |       |      | *    |       |     | *    | V        |
| Leakage Current <sup>(3)</sup>         | Input-to-Output                                          | 10    6 |       |      |       | *    |      |       | *   |      | GΩ    pF |
|                                        | Input-to-Output, 240V, 60Hz                              |         |       | 1    |       |      | *    |       |     | *    | μA       |
| <b>OUTPUT</b>                          |                                                          |         |       |      |       |      |      |       |     |      |          |
| Rated Output Voltages <sup>(4)</sup>   | $I_{LOAD} = 3\text{mA}$ per Output                       | 15      |       | 16.6 | *     |      | *    | *     |     | *    | VDC      |
|                                        | $I_{LOAD} = 16\text{mA}$ per Output                      | 14.3    |       | 16.2 | *     |      | *    | *     |     | *    | VDC      |
|                                        | $I_{LOAD} = 40\text{mA}$ per Output                      | —       | —     | —    | 13.0  | 14.2 | 16.2 | —     | —   | —    | VDC      |
| Output Current                         | Total of All Outputs                                     |         |       | 200  |       |      | *    |       |     | *    | mA       |
|                                        | Any One Output <sup>(5)</sup>                            | 3       |       | 100  | *     |      | *    | *     |     | *    | mA       |
| Load Regulation                        |                                                          |         | (5)   |      |       | *    |      |       | *   |      | mVpk     |
| Ripple Voltage                         | $I_{LOAD} = 3\text{mA}$ per Output                       |         | 15    |      |       | *    |      |       | *   |      | mVpk     |
|                                        | $I_{LOAD} = 16\text{mA}$ per Output                      |         | 35    | 100  |       | *    | *    |       | *   | *    | mVpk     |
|                                        | $I_{LOAD} = 40\text{mA}$ per Output                      |         | —     |      |       | 50   |      |       | *   | *    | mVpk     |
| Tracking Error between Dual Outputs    | Balanced Loads                                           |         | ±200  |      |       | *    |      |       | *   |      | mVDC     |
| Sensitivity to Input Voltage Changes   |                                                          |         | 1.13  |      |       | *    |      |       | *   |      | V/V      |
| Output Voltage Temperature Coefficient | $T_A = T_{\text{SPECIFICATION RANGE}}$                   |         | ±0.02 |      |       | *    |      |       | *   |      | %/°C     |
| <b>TEMPERATURE</b>                     |                                                          |         |       |      |       |      |      |       |     |      |          |
| Specification                          | $I_{LOAD} \leq 16\text{mA}$ per Output                   | −25     |       | +85  | *     |      | *    | *     |     | *    | °C       |
|                                        | $I_{LOAD} \leq 40\text{mA}$ per Output                   | −25     |       | +60  | *     |      | *    | *     |     | *    | °C       |
| Storage                                |                                                          | −55     |       | +125 | *     |      | *    | *     |     | *    | °C       |
| Junction Temperature                   |                                                          |         |       | +125 |       |      | *    |       |     | *    | °C       |

\* Specifications same as 722.

NOTES: (1) For ambient temperature above  $+70^\circ\text{C}$ , the input voltage is 12.5V (max). The input voltage remains 16V (max) if case temperature is kept below  $+85^\circ\text{C}$ . (2) External capacitor across P+ to V− pins and 12" of #24 wire to  $V_{IN}$ . (3) Reference UL544, paragraph 27.5, Leakage Current. (4) See Typical Characteristics. (5) A minimum output current of 3mA at each output is recommended to maintain output voltage accuracy.

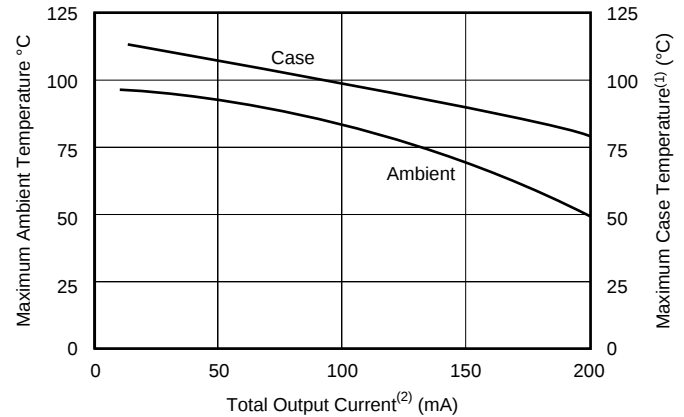
# TYPICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_{IN} = 15\text{VDC}$ ,  $C = 0.47\mu\text{F}$ , and  $R_1$  selected per typical characteristic, unless otherwise noted.

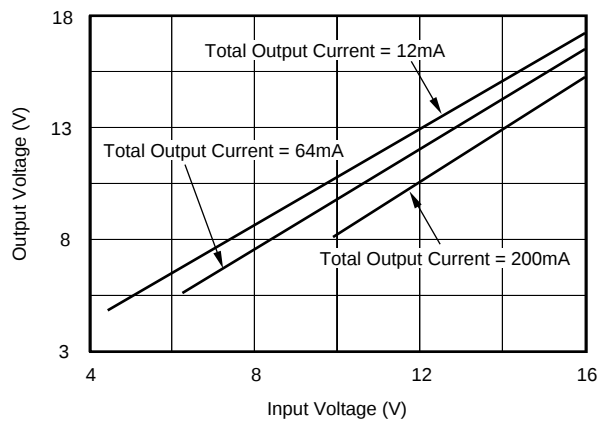
SELECTION OF  $R_1$  OR EXTERNAL VOLTAGE  $V_+$  FOR MINIMUM INTERNAL POWER DISSIPATION

|                   |            | MAXIMUM OUTPUT CURRENT FROM ANY SINGLE OUTPUT |              |              |
|-------------------|------------|-----------------------------------------------|--------------|--------------|
|                   |            | <16mA                                         | 16mA to 30mA | 30mA         |
| Input Voltage (V) | >13        | 1.3k $\Omega$                                 | 820 $\Omega$ | 510 $\Omega$ |
|                   | 11 to 13   | 820 $\Omega$                                  | 510 $\Omega$ | 200 $\Omega$ |
|                   | 9 to 11    | 510 $\Omega$                                  | 200 $\Omega$ | 0 $\Omega$   |
|                   | 8 to 9     | 200 $\Omega$                                  | 0 $\Omega$   | —            |
|                   | <8         | 0 $\Omega$                                    | —            | —            |
|                   | $V_{+EXT}$ | 6.5V                                          | 7.5V         | 9.0V         |

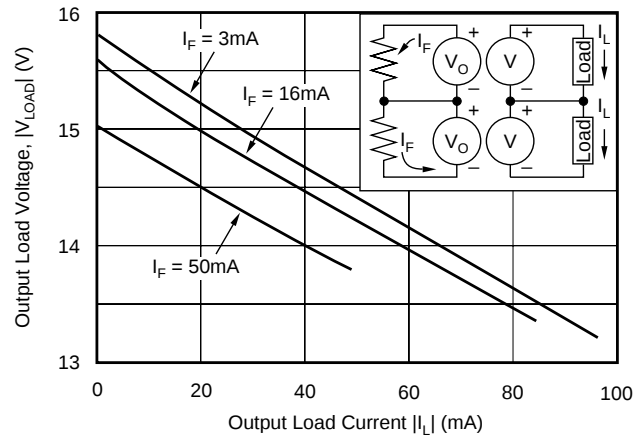
MAXIMUM SAFE OPERATING TEMPERATURE vs TOTAL OUTPUT CURRENT



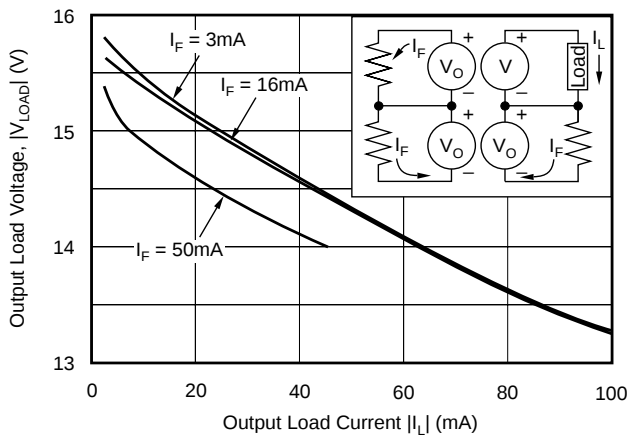
OUTPUT VOLTAGE vs INPUT VOLTAGE



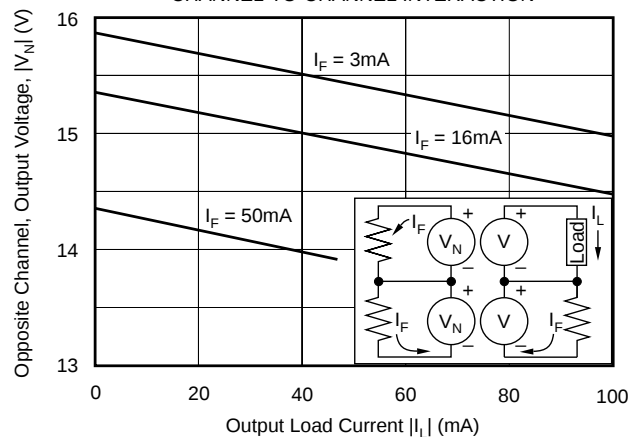
SINGLE-CHANNEL LOAD REGULATION



SINGLE OUTPUT LOAD REGULATION



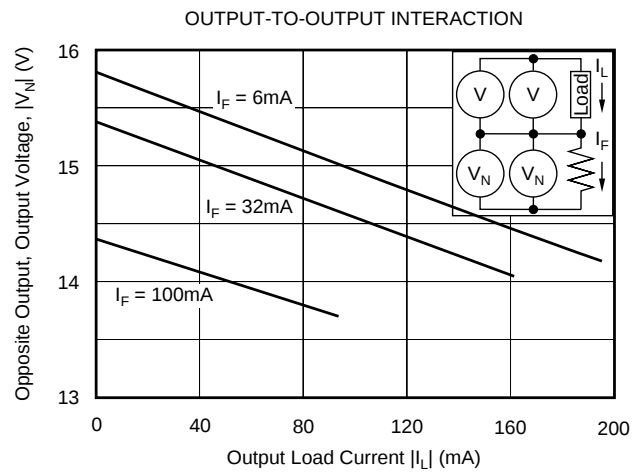
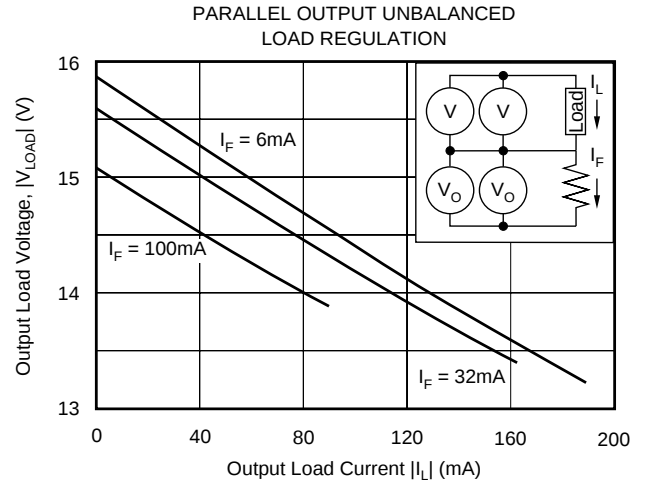
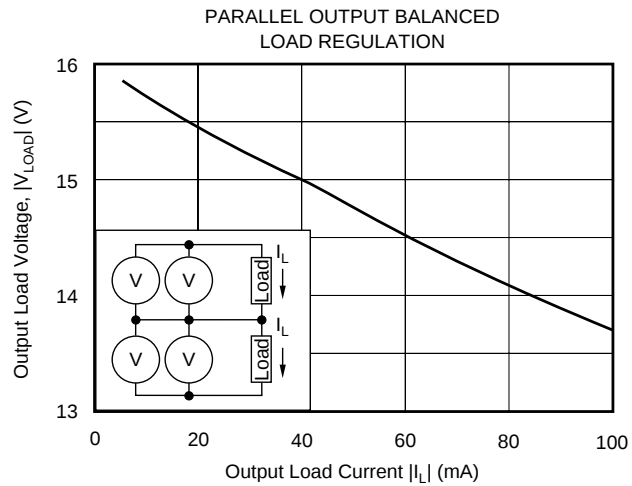
CHANNEL-TO-CHANNEL INTERACTION



NOTES: (1) Using a 104mm x 19mm x 1.6mm aluminum strip mounted to the bottom of the case with heat sink compound. (2) Total output current is the sum of the currents for each individual output.

# TYPICAL CHARACTERISTICS (Cont.)

At  $T_A = +25^\circ\text{C}$ ,  $V_{IN} = 15\text{VDC}$ ,  $C = 0.47\mu\text{F}$ , and  $R_1$  selected per typical characteristic, unless otherwise noted.



# INSTALLATION AND OPERATING INSTRUCTIONS

Typical application connections for the 722 are shown in Figures 1 and 2. Primary power ( $V_{IN}$ ) is applied at the P+ and V- terminals. The common or ground for  $V_{IN}$  may be connected to either P+ or V-; the only requirement is that P+ and V+ must be positive with respects to V-.

Power for the internal oscillator and switch drivers is derived from the primary power by a voltage dropping resistor,  $R_1$ . The value of  $R_1$  as a function of  $V_{IN}$  is shown in the Typical Characteristics section. Alternately, voltage for the V+ terminal can be obtained from a separate source. V+ should be +5V to +7.5V positive with respect to V-. If a separate source is used, the V+ input must be applied before the P+ input in order to avoid possible damage to the unit. P+ and V+ must remain positive with respect to V- at all times (including transients). If necessary, diode clamps should be attached across these inputs.

The E pin enables the converter when connected to V+ and disables it when connected to V-.

An external capacitor, C (0.47 $\mu$ F ceramic), is used to reduce input ripple. It should be connected as close to the P+ and V- pins as practical. Input leads to these terminals should also be kept as short as possible. External shielding may be appropriate in applications where RFI at the 900kHz nominal oscillator frequency is a problem because the 722 is not internally shielded.

Each output is filtered with an internal 0.22 $\mu$ F capacitor. Output ripple voltage can be reduced below the specified value by adding external capacitors up to 10 $\mu$ F between each output and its common.

## DISCUSSION

### OUTPUT CURRENT RATINGS

At rated output voltage accuracy, the 722 is capable of providing 64mA divided among its four outputs<sup>(1)</sup>. A minimum average output current of 3mA is recommended at each output to maintain voltage accuracy.

Output channels<sup>(2)</sup> can be connected in series or parallel for higher output voltage or current.

### ISOLATION CONFIGURATIONS

The fact that the two outputs of the 722 are isolated from the input and from each other allows both two-port and three-port isolation connections.

Figure 1 shows TI's 3650 optically coupled isolation amplifier connected in three-port configuration. One of the 722 channels provides power to the 3650 input. The other channel supplies power to the 3650 output. The amplifier input and output are isolated from each other and the system power supply common. In this configuration, the 722 channel-to-channel isolation specification applies to the amplifier input-to-output voltage.

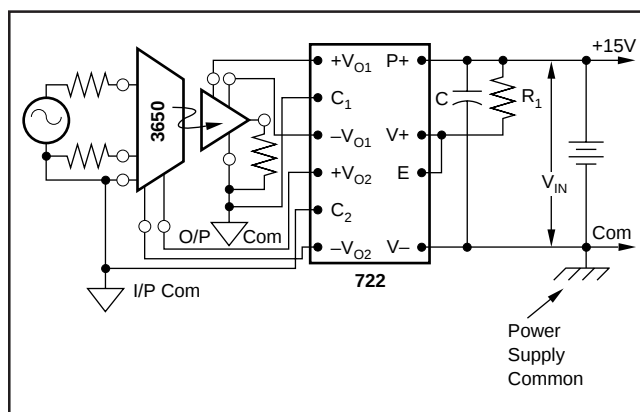


FIGURE 1. Three-Port Isolation.

NOTES: (1) "Output" denotes a single output terminal (+V or -V) and its associated common. (2) "Channel" denotes a pair of outputs (+V and -V) and their associated common.

The diagram shows a 722 dual inverter with two comparators (3650) and two input comparators. The 722 is configured with its non-inverting inputs (P+ and V+) connected to the outputs of the two comparators. The inverting inputs (V- and E) are connected to a common input signal  $V_{IN}$ . The output of the 722 is connected to a common output terminal (O/P Com). The two comparators are connected to the 722's inputs and have their own outputs (O/P Com) connected to the common output terminal. The input comparators are connected to the 722's inputs and have their own outputs (O/P Com) connected to the common output terminal. The 722 is powered by +15V and -15V supplies, and the comparators are powered by +15V and -15V supplies.

## SHORT CIRCUIT PROTECTION

FIGURE 3. Short-Circuit Protection.

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 0722BG           | NRND                  | CDIP         | JND             | 20   |             | TBD                     | Call TI          | Call TI                      |
| 0722MG           | NRND                  | CDIP         | JND             | 20   |             | TBD                     | Call TI          | Call TI                      |
| 722G             | OBSOLETE              | CDIP         | JND             | 20   |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

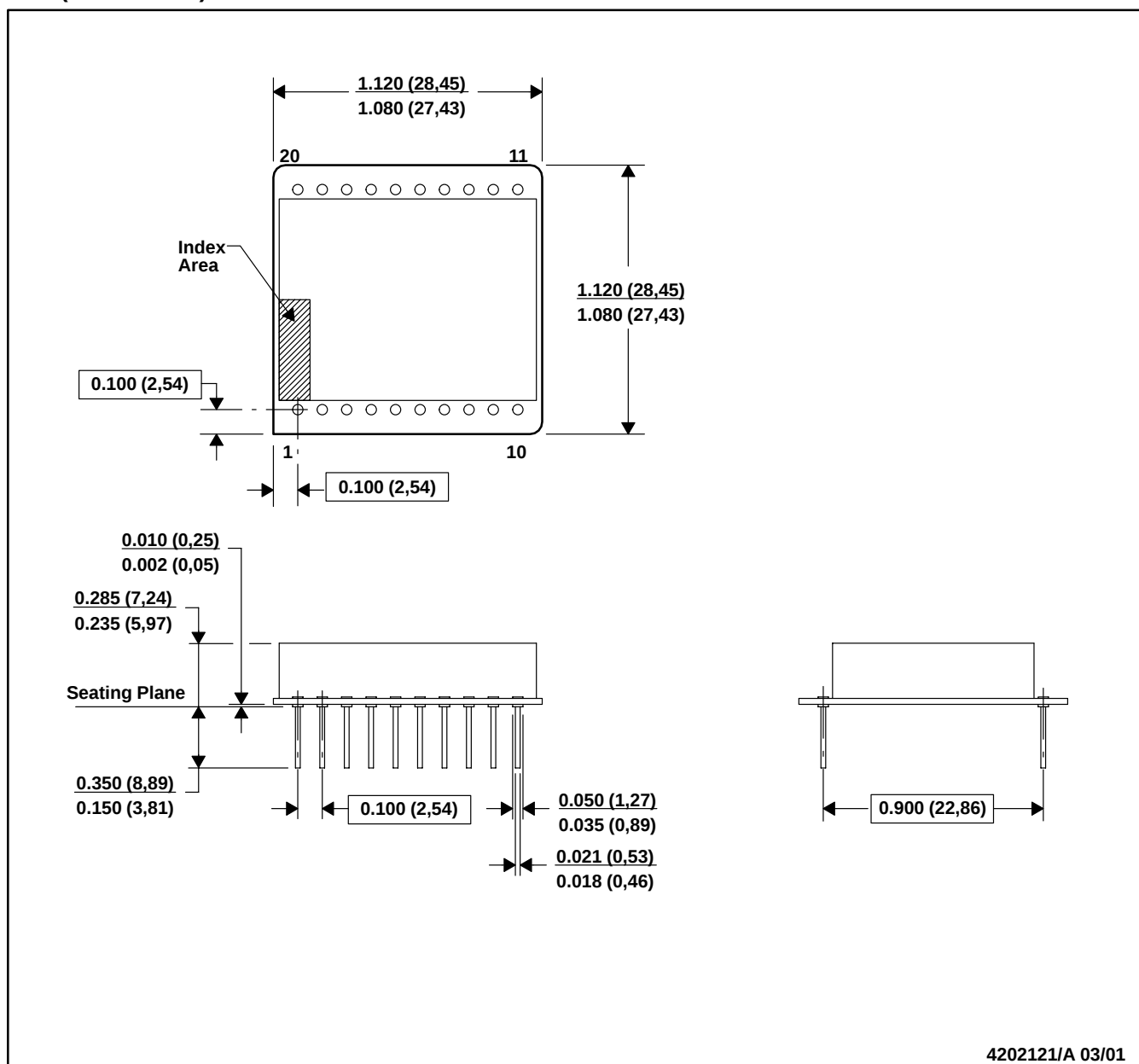
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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JND (R-CDIP-P20)

CERAMIC DUAL-IN-LINE



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - Leads in true position within 0.010 (0,25) R @ MMC at seating plane.
  - Pin numbers shown for reference only. Numbers may not be marked on package.
  - A visual index feature must be located within the cross-hatched area.

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| DLP® Products               | <a href="http://www.dlp.com">www.dlp.com</a>                       |
| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
| Clocks and Timers           | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>           |
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| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
| RFID                        | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               |
| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               |

### Applications

|                    |                                                                          |
|--------------------|--------------------------------------------------------------------------|
| Audio              | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                   |
| Automotive         | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| Broadband          | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Digital Control    | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
| Medical            | <a href="http://www.ti.com/medical">www.ti.com/medical</a>               |
| Military           | <a href="http://www.ti.com/military">www.ti.com/military</a>             |
| Optical Networking | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Security           | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
| Telephony          | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
| Video & Imaging    | <a href="http://www.ti.com/video">www.ti.com/video</a>                   |
| Wireless           | <a href="http://www.ti.com/wireless">www.ti.com/wireless</a>             |

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