

MC78BC00 Series

Micropower Voltage Regulator

The MC78BC00 voltage regulators are specifically designed to be used with an external power transistor to deliver high current with high voltage accuracy and low quiescent current.

The MC78BC00 series are devices suitable for constructing regulators with ultra-low dropout voltage and output current in the range of several tens of mA to hundreds of mA. These devices have a chip enable function, which minimizes the standby mode current drain. Each of these devices contains a voltage reference unit, an error amplifier, a driver transistor and feedback resistors. These devices are available in the SOT-23, 5 pin surface mount packages.

These devices are ideally suited for battery powered equipment, and power sources for hand-held audio instruments, communication equipment and domestic appliances.

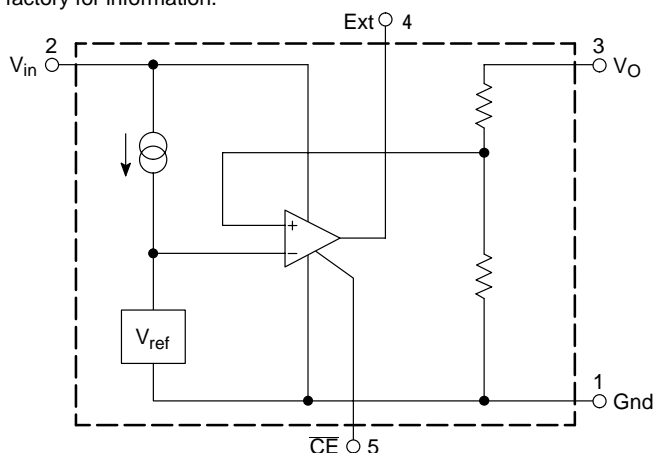
Features

- Ultra-Low Supply Current (50 μ A)
- Standby Mode (0.2 μ A)
- Ultra-Low Dropout Voltage (0.1 V with External Transistor and $I_O = 100$ mA)
- Excellent Line Regulation (Typically 0.1%/V)
- High Accuracy Output Voltage ($\pm 2.5\%$)

ORDERING INFORMATION

| Device | Output Voltage | Operating Temperature Range | Package |
|-------------|----------------|--|---------|
| MC78BC30NTR | 3.0 | $T_A = -30^\circ$ to $+80^\circ\text{C}$ | SOT-23 |
| MC78BC31NTR | 3.1 | | |
| MC78BC33NTR | 3.3 | | |
| MC78BC40NTR | 4.0 | | |
| MC78BC43NTR | 4.3 | | |
| MC78BC45NTR | 4.5 | | |
| MC78BC50NTR | 5.0 | | |

Other voltages from 2.0 to 6.0 V, in 0.1 V increments, are available. Consult factory for information.



This device contains 13 active transistors.

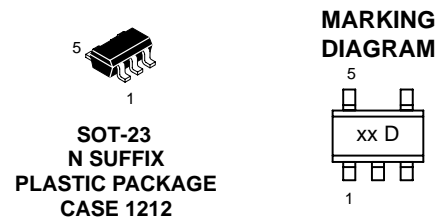
Figure 1. Representative Block Diagram



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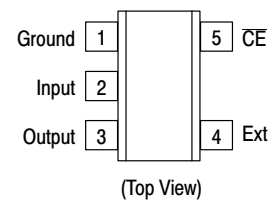
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VOLTAGE REGULATOR WITH EXTERNAL POWER TRANSISTOR

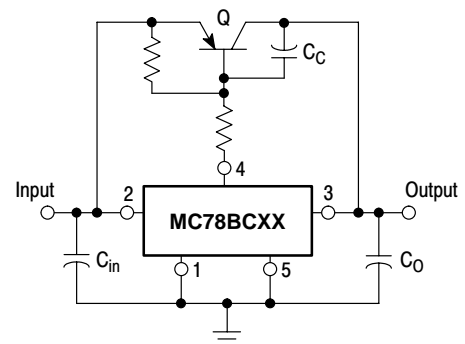


xx = MC78BC30NTR = K0
 = MC78BC31NTR = K1
 = MC78BC33NTR = K3
 = MC78BC40NTR = L0
 = MC78BC43NTR = L3
 = MC78BC45NTR = L5
 = MC78BC50NTR = M0
 D = Date Code

PIN CONNECTIONS



Standard Application



MC78BC00 Series

MAXIMUM RATINGS ($T_C = 25^\circ\text{C}$, unless otherwise noted.)

| Rating | Symbol | Value | Unit |
|--|--------------------|-------------|---------------------------------|
| Input Voltage | V_{CC} | 10 | Vdc |
| Power Dissipation and Thermal Characteristics Maximum Power Dissipation Case 1212 (SOT-23) H Suffix Thermal Resistance, Junction-to-Ambient | P_D R_{qJA} | 150 333 | mW $^\circ\text{C}/\text{W}$ |
| Operating Junction Temperature | T_J | 125 | $^\circ\text{C}$ |
| Operating Ambient Temperature | T_A | -30 to +80 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | -40 to +125 | $^\circ\text{C}$ |

NOTE: ESD data available upon request.

ELECTRICAL CHARACTERISTICS ($V_{in} = V_O + 1.0\text{ V}$, $I_O = 50\text{ mA}$, $T_J = 25^\circ\text{C}$ 9 (Note 1), unless otherwise noted.)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---------------------|---|---|---|-----------------------|
| Output Voltage MC78BC30NTR MC78BC31NTR MC78BC33NTR MC78BC40NTR MC78BC43NTR MC78BC45NT4 MC78BC50NTR | V_O | 2.925 3.023 3.218 3.900 4.193 4.386 4.875 | 3.0 3.1 3.3 4.0 4.3 4.5 5.0 | 3.075 3.178 3.382 4.100 4.408 4.613 5.125 | V |
| Line Regulation $V_O + 0.5\text{ V} \leq V_{in} \leq 8.0\text{ V}$ | Reg_{line} | 0 | 0.1 | 0.3 | mV |
| Load Regulation $V_{in} - V_O = 1.0\text{ V}$ $1.0\text{ mA} \leq I_O \leq 100\text{ mA}$ | Reg_{load} | - | 40 | 60 | mV |
| Output Current (Note 2) $V_{in} - V_O = 1.0\text{ V}$ | I_O | - | 1000 | - | mA |
| Dropout Voltage $I_O = 100\text{ mA}$ | $V_{in} - V_O$ | - | 100 | 200 | mV |
| Supply Current $V_{in} = 8.0\text{ V}$ $V_{in} - V_O = 1.0\text{ V}$ $I_O = 0$ (at no load) | I_{ss} | - | 50 | 80 | μA |
| Supply Current (Standby) $V_{in} = 8.0\text{ V}$ | $I_{standby}$ | 0.1 | 0.2 | 1.0 | μA |
| Ext Leakage Current | I_{LK} | - | - | 0.5 | μA |
| Chip Enable Input Logic Voltage Logic "0" (Regulator "On") Logic "1" (Regulator "Off") | V_{CE} | 0 1.5 | - - | 0.25 8.0 | V |
| Chip Enable Input Current $V_{CE} = 0.25\text{ V}$ $V_{CE} = 1.5\text{ V}$ | I_{CEL} | -5.0 - | -3.0 - | -0.1 0.1 | μA |
| Output Voltage Temperature Coefficient | T_C | - | ± 100 | - | ppm/ $^\circ\text{C}$ |

1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
2. The output current depends upon the performance of External PNP Transistor. Use External PNP Transistor of a low saturation type, with an H_{FE} of 100 or more.

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DEFINITIONS

Dropout Voltage - The input/output voltage differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 100 mV below its nominal value (which is measured at 1.0 V differential), dropout voltage is affected by junction temperature, load current and minimum input supply requirements.

Line Regulation - The change in output voltage for a change in input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques

such that average chip temperature is not significantly affected.

Load Regulation - The change in output voltage for a change in load current at constant chip temperature.

Maximum Power Dissipation - The maximum total device dissipation for which the regulator will operate within specifications.

Supply Current - Current which is used to operate the regulator chip and is not delivered to the load.

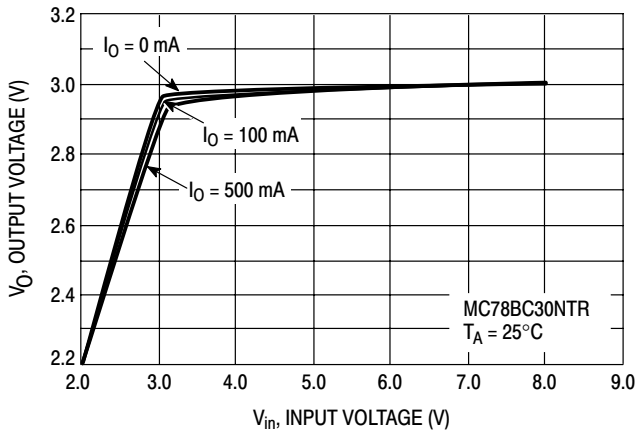


Figure 1. Output Voltage versus Input Voltage

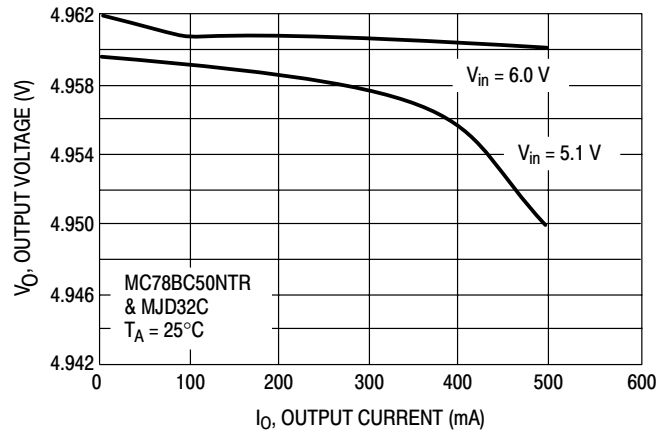


Figure 2. Output Voltage versus Output Current

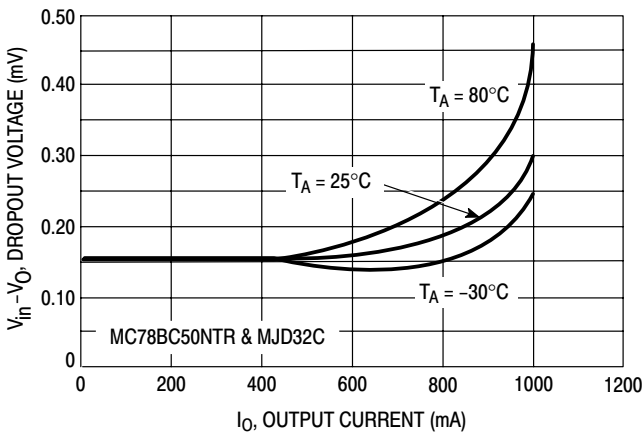


Figure 3. Dropout Voltage versus Output Current

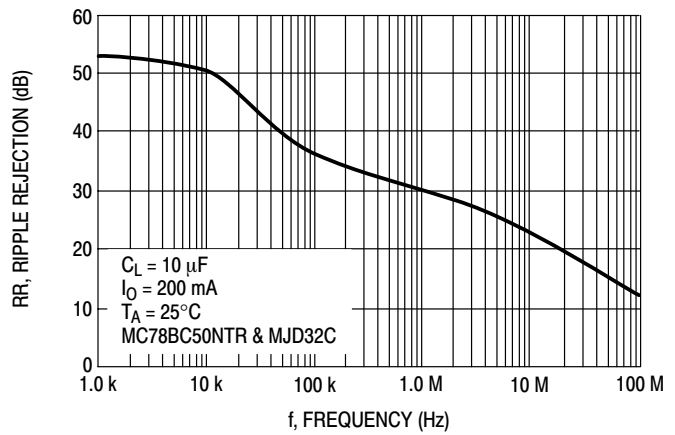


Figure 4. Ripple Rejection as a Function of Frequency

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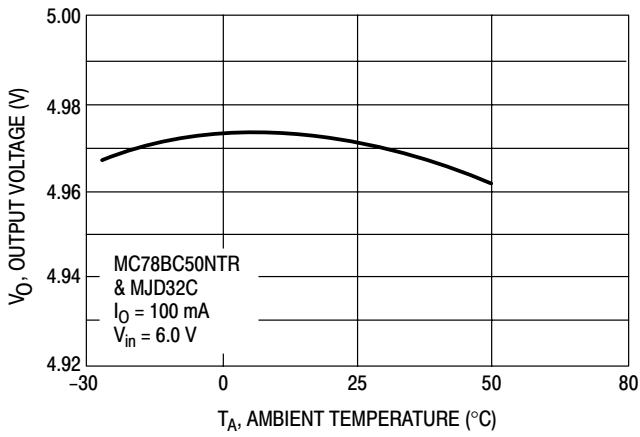


Figure 5. Output Voltage versus Temperature

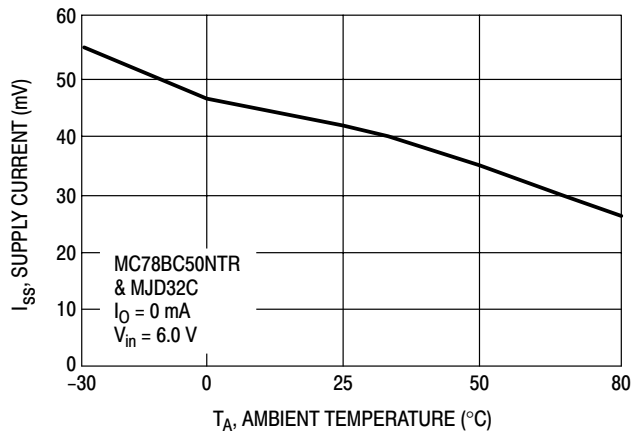


Figure 6. Supply Current versus Temperature

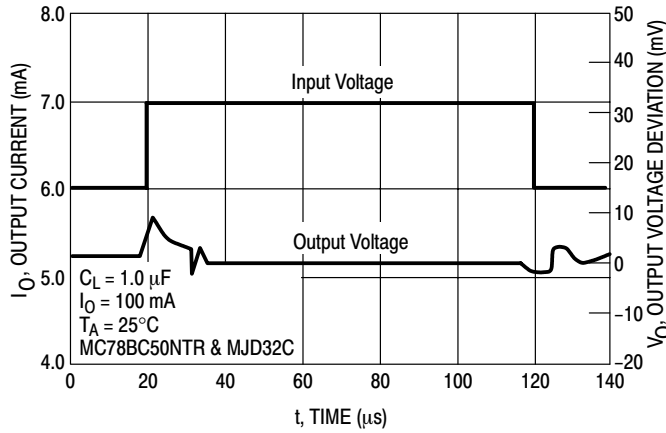


Figure 7. Line Transient Response

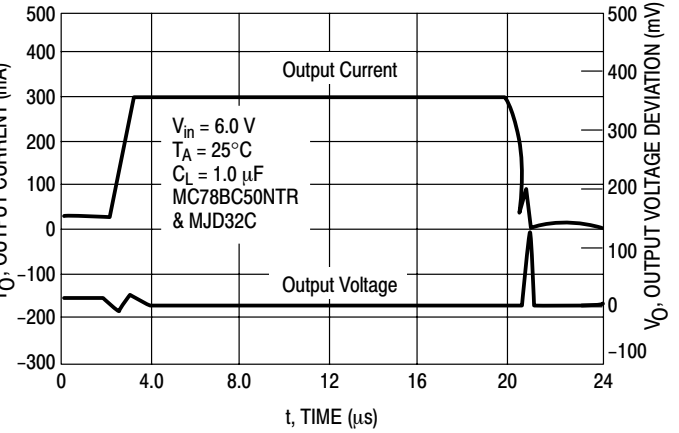


Figure 8. Load Transient Response

MC78BC00 Series

APPLICATIONS INFORMATION

Introduction

The MC78BC00 series of micropower voltage regulators are specifically designed for ultra-low dropout voltage and an output current which ranges from several tens of mA to several hundreds of mA making them ideal for battery-powered equipment. These regulators also have a chip enable function which minimizes supply current in stand-by mode. An input bypass capacitor is recommended if the regulator is located an appreciable distance (≥ 4 inches) from the input voltage source. These regulators require a $10\ \mu\text{F}$ capacitance between the output terminal and ground for stability. Most types of aluminum, tantalum or multilayer ceramic will perform adequately. Solid tantalums or other appropriate capacitors are recommended for

operation below 25°C . The bypass capacitors should be mounted with the shortest possible leads or track lengths directly across the regulator input and output terminals.

With economical electrolytic capacitors, cold temperature operation can pose a serious stability problem. As the electrolyte freezes, around -30°C , the capacitance will decrease and the equivalent series resistance (ESR) will increase drastically, causing the circuit to oscillate. Quality electrolytic capacitors with extended temperature ranges of -40° to $+85^\circ\text{C}$ are readily available. Solid tantalum capacitors may be the better choice if small size is a requirement. However, a maximum ESR limit of $3.0\ \Omega$ must be observed over temperature to maintain stability.

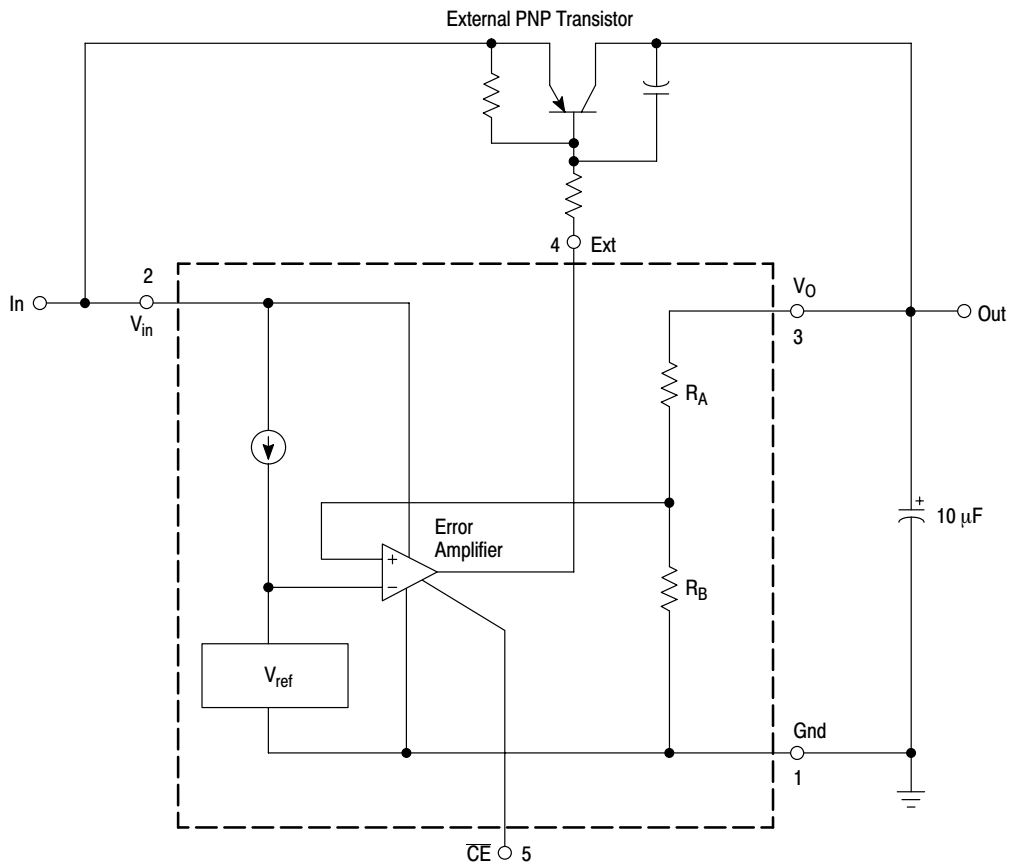


Figure 9. Typical Operation

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External PNP Transistor

The external pin of this IC is protected by a current limit circuit from the destruction caused by excess current. The R2 resistor shown in Figure 10 is used for the protection of

the external transistor, although this circuit can operate without the resistor. Resistor R2 should be determined via the input voltage, output voltage, output current, temperature and the H_{FE} of the external pass transistor.

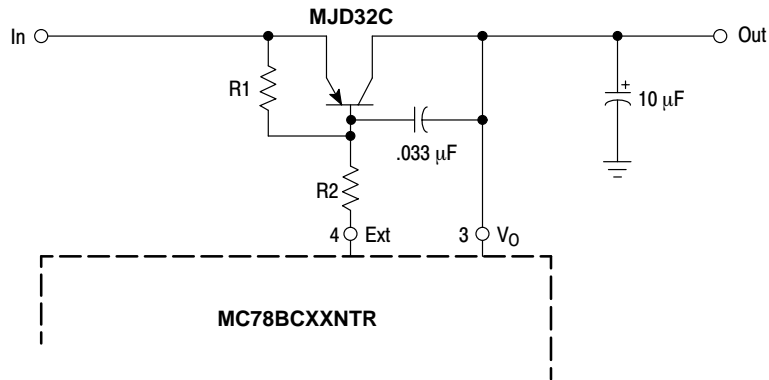


Figure 10. External PNP

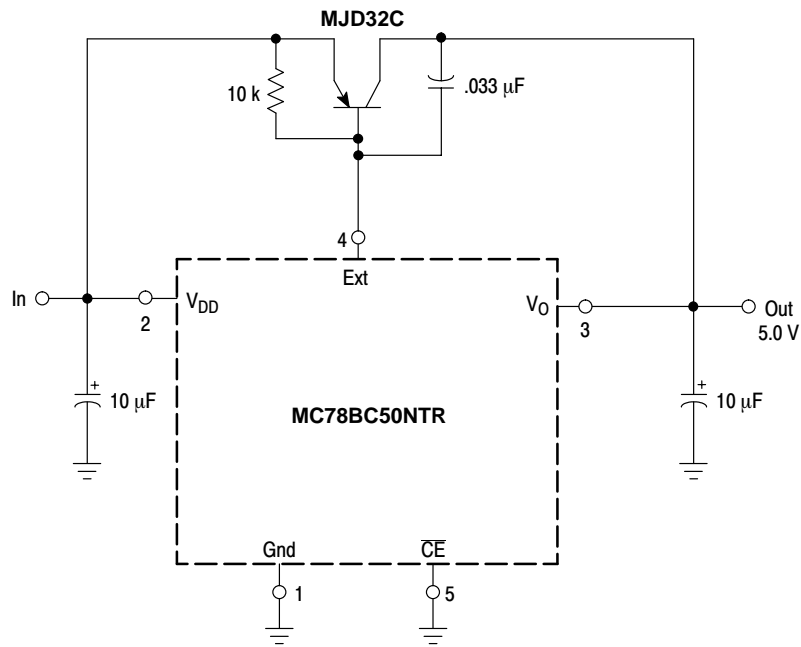
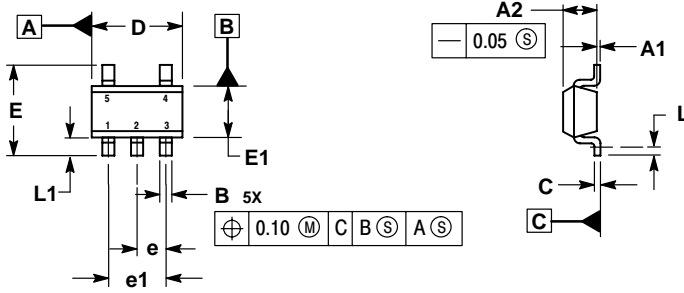


Figure 11. Typical Application

MC78BC00 Series

PACKAGE DIMENSIONS

N SUFFIX
 PLASTIC PACKAGE
 CASE 1212-01
 (SOT-23)
 ISSUE O



NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM C IS A SEATING PLANE.

| DIM | MILLIMETERS | |
|-----|-------------|------|
| | MIN | MAX |
| A1 | 0.00 | 0.10 |
| A2 | 1.00 | 1.30 |
| B | 0.30 | 0.50 |
| C | 0.10 | 0.25 |
| D | 2.80 | 3.00 |
| E | 2.50 | 3.10 |
| E1 | 1.50 | 1.80 |
| e | 0.95 BSC | |
| e1 | 1.90 BSC | |
| L | 0.20 | --- |
| L1 | 0.45 | 0.75 |

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