

1A Single Chip Li-Ion and Li-Polymer Charger

General Description

The LP28013S is a complete constant-current/constant voltage linear charger for single cell lithium-ion battery. No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture. Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V/4.35V, and the charge current can be programmed externally by ISET pin with a single resistor.

The LP28013S automatically terminates the charge cycle when the charge current drops to 1/10 setting current value after the final float voltage is reached.

Other features include charge current monitor, under voltage lockout, automatic recharge, status pins and battery temperature detection.

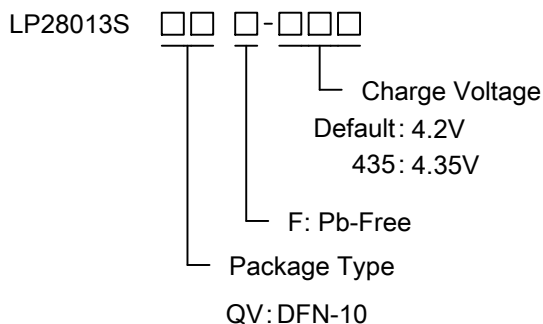
Features

- ◆ Input Voltage up to 28V
- ◆ Input Over Voltage Protection : 7V
- ◆ Short-circuit protection
- ◆ Programmable Charge Current up to 1A
- ◆ 1µA Battery Reverse Current
- ◆ Over temperature Sensing Protection
- ◆ Protection of Reverse Connection of Battery
- ◆ Constant-Current/Constant-Voltage Operation with Thermal Regulation
- ◆ TDFN-10 Package
- ◆ RoHS Compliant and 100% Lead (Pb)-Free

Applications

- ◇ Portable Media Players/Game
- ◇ Power Bank
- ◇ Bluetooth Applications
- ◇ PDA/MID

Order Information

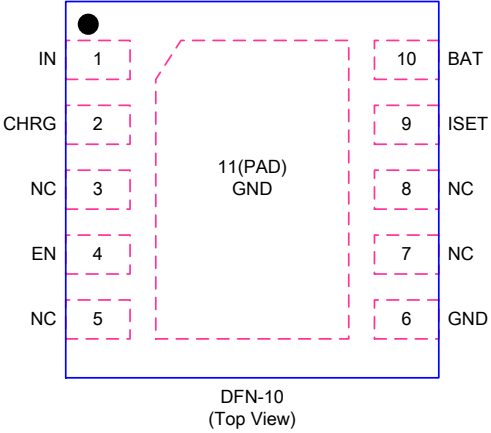


Marking Information

| Device | Marking | Package | Shipping |
|-----------------|---------------------------|---------|----------|
| LP28013SQVF | LPS LP28013S YWX | TDFN-10 | 5K/REEL |
| LP28013SQVF-435 | LPS LP28013S 435YWX | TDFN-10 | 5K/REEL |

Marking indication:
Y:Production year W:Production week X: Series Number

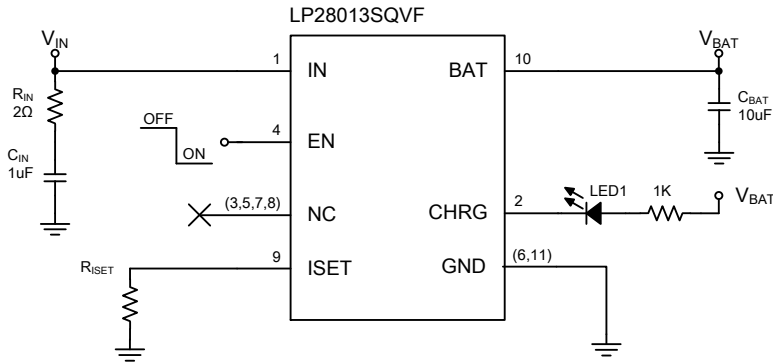
Functional Pin Description

| Package Type | Pin Configurations |
|--------------|--|
| TDFN-10 |  |

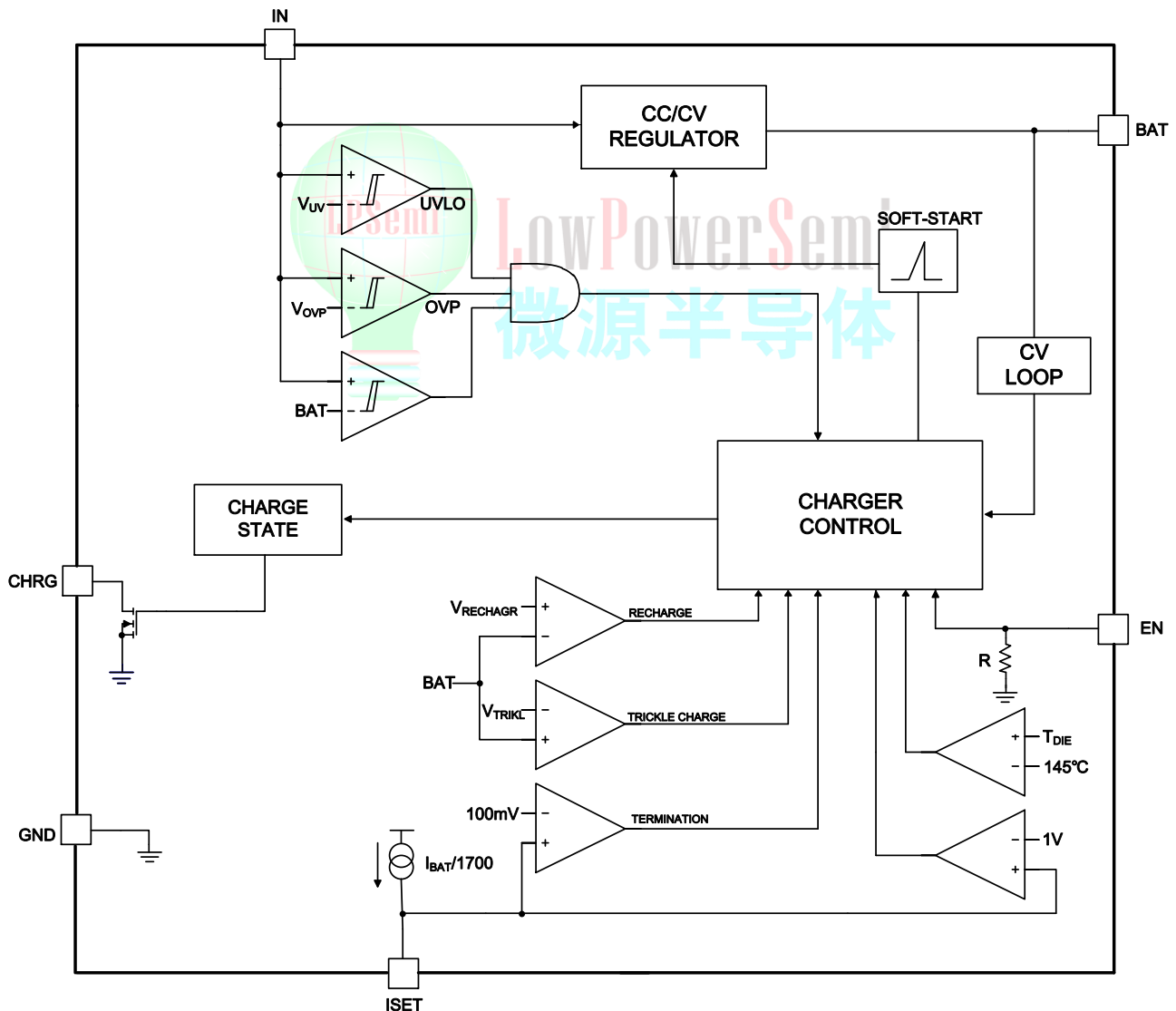
Pin Description

| No. | NAME | DESCRIPTION |
|---------|------|--|
| 1 | IN | IN is the input power source. Connect to a wall adapter. |
| 2 | CHRG | Open-Drain Charge Status Output. When the battery is charging, the CHRG pin is pulled low by an internal NMOS. When the charge cycle is completed, the pin could be pulled High by an external pull high resistor. |
| 3/5/7/8 | NC | No Connector. |
| 4 | EN | Charge Enable Input (active low). |
| 6/11 | GND | GND is the connection to system ground. |
| 9 | ISET | Charge Current Program. The charge current is programmed by connecting a 1% resistor (R_{ISET}) to ground. |
| 10 | BAT | BAT is the connection to the battery. Typically a 10 μ F capacitor is needed. |

Typical Application Circuit



Functional Block Diagram



Absolute Maximum Ratings ^{Note 1}

| | |
|--|----------------|
| ✧ Input Voltage to GND | -0.3V to 28V |
| ✧ BAT Voltage GND | - 5V to 15V |
| ✧ Other pin to GND | -0.3V to 6.5V |
| ✧ Maximum Junction Temperature(T_J) | 150°C |
| ✧ Maximum Soldering Temperature (at leads, 10 sec) | 260°C |
| ✧ Operating Junction Temperature Range | -20°C to 85°C |
| ✧ Storage Temperature | -60°C to 125°C |

Thermal Information

| | |
|--|--------|
| ✧ Maximum Power Dissipation (P_D , $T_A=25^\circ\text{C}$) | 1.5W |
| ✧ Thermal Resistance (θ_{JA}) | 65°C/W |

ESD Susceptibility

| | |
|-------------------------|------|
| ✧ HBM(Human Body Model) | 2KV |
| ✧ MM(Machine Model) | 200V |

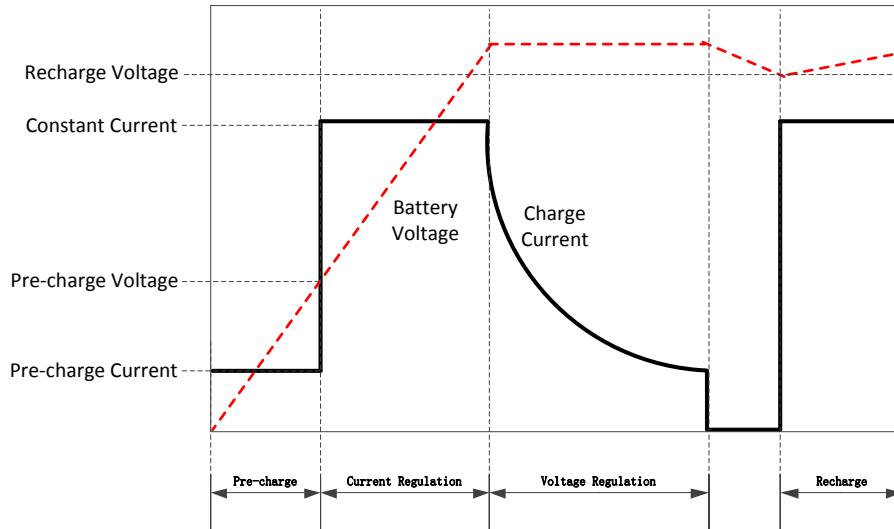
Note 1. Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

($T_A=25^{\circ}\text{C}$, $V_{IN}=5\text{V}$, unless otherwise noted.)

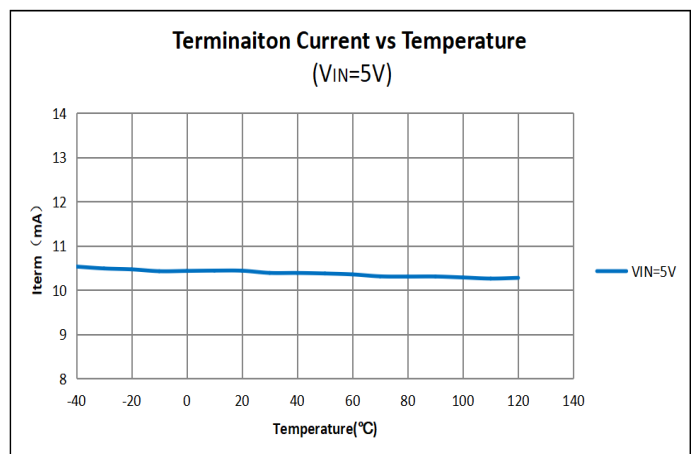
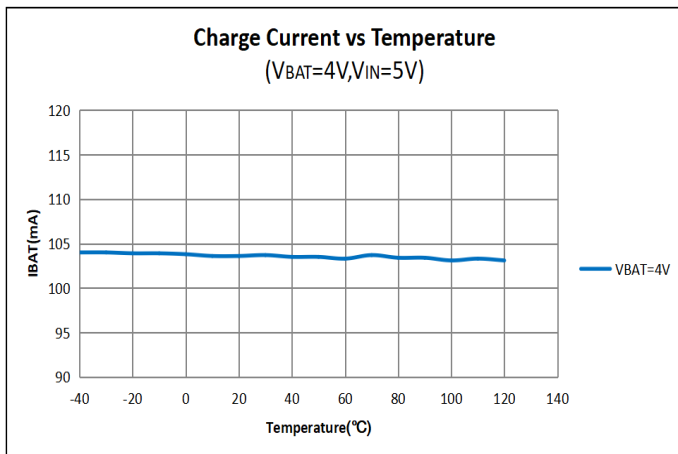
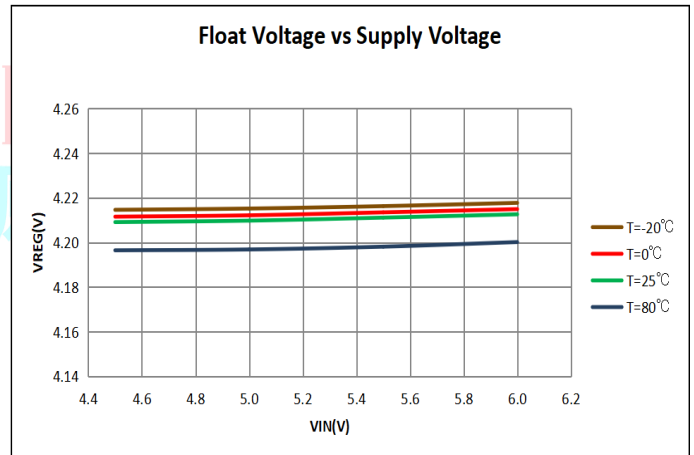
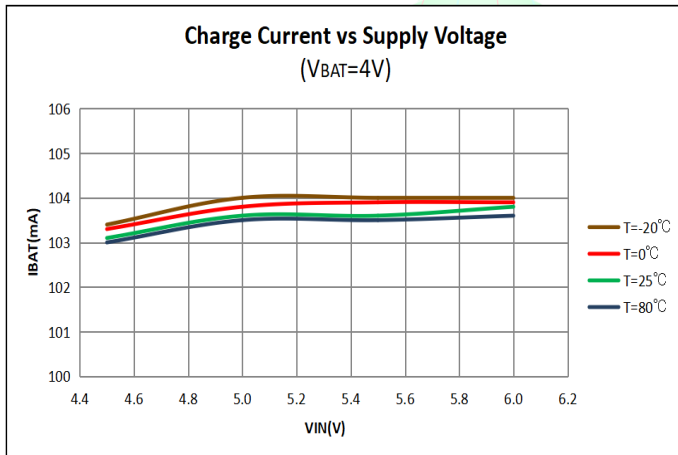
| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP. | MAX | UNITS |
|---------------------|---|--|-------|------|-------|--------------------|
| V_{IN} | Input Voltage | | 4.5 | 5 | 6.5 | V |
| I_{IN} | Input Supply Current | $R_{ISET}=17\text{K}$, Charge Mode | | 300 | | μA |
| | | $V_{BAT}=4.2\text{V}$, Charge Terminated | | 160 | | μA |
| | | $R_{ISET}=\text{NC}$, Shutdown Mode | | 200 | | μA |
| V_{FLOAT} | Regulated Output (Float) Voltage | LP28013SQVF, $I_{BAT}=40\text{mA}$, | 4.158 | 4.2 | 4.242 | V |
| | | LP28013SQVF-435, $I_{BAT}=40\text{mA}$ | 4.31 | 4.35 | 4.39 | V |
| V_{UV} | V_{IN} Under Voltage Lockout Threshold | From V_{IN} Low to High | | 3.5 | | V |
| V_{UV_HYS} | Under Voltage Lockout Hysteresis | | | 110 | | mV |
| V_{OVP} | Input Voltage OVP | V_{IN} Rising | | 7 | | V |
| V_{OVP_HYS} | OVP Hysteresis | | | 150 | | mV |
| I_{BAT} | BAT Pin Current | $R_{ISET}=3.4\text{k}$, Current Mode | 450 | 500 | 550 | mA |
| | | $R_{ISET}=17\text{k}$, Current Mode | 90 | 100 | 110 | mA |
| | | $V_{BAT}=4.2\text{V}$ ($V_{IN}=\text{float}$ or 0V) | | 1 | | μA |
| I_{TRIKL} | Trickle Charge Current | $V_{BAT}<V_{TRIKL}$, $R_{ISET}=10\text{k}$, Charge Mode | | 10 | | $\%I_{BAT}$ |
| V_{TRIKL} | Trickle Charge Threshold Voltage | V_{BAT} Rising | | 2.6 | | V |
| V_{TRIKL_HYS} | Trickle Charge Hysteresis Voltage | | | 150 | | mV |
| I_{TERM} | Termination Current Threshold | | | 10 | | $\%I_{BAT}$ |
| V_{ISET} | ISET Pin Voltage | $R_{ISET}=10\text{k}$, Current Mode | 0.9 | 1 | 1.1 | V |
| I_{STAT} | CHRG Pin Sink Current | $V_{CHRG}=5\text{V}$ | | | 1 | μA |
| V_{STAT} | CHRG Pin Output Low Voltage | $I_{CHRG}=5\text{mA}$ | | | 0.5 | V |
| ΔV_{RECHRG} | Recharge Battery Threshold Voltage | $V_{FLOAT}-V_{RECHRG}$ | | 150 | | mV |
| V_{ASD} | $V_{IN} - V_{BAT}$ Lockout Threshold Voltage | $V_{BAT}=3.5\text{V}$, V_{IN} Rising | | 150 | | mV |
| V_{EN_ON} | EN Logic-Low Voltage Threshold | | | | 0.4 | V |
| V_{EN_OFF} | EN Logic-High Voltage Threshold | | 1.4 | | | V |
| T_{LIM} | Junction Temperature in Constant Temperature Mode | | | 145 | | $^{\circ}\text{C}$ |

Typical Charging Profile



Typical Performance Characteristics

($C_{IN}=C_{OUT}=10\mu F, R_{ISET}=16.5K$, unless otherwise noted)



Application Information

The LP28013S has built-in input voltage surge protection as high as +28V. The charger IC will be automatically disabled when the input voltage is higher than 7V. A charge cycle begins when EN is high, the voltage at the IN pin rises above the UVLO threshold level and a program resistor is connected from the ISET pin to ground. If the BAT pin is less than 2.6V, the charger enters trickle charge mode. In this mode, the LP28013S supplies approximately 1/10 the ISET programmed charge current to bring the battery voltage up to a safe level for full current charging. When the BAT pin voltage rises above 2.6V, the charger enters constant-current mode(CC), where the ISET programmed charge current is supplied to the battery. When the Battery Voltage approaches the final float voltage, It enters constant-voltage mode(CV) and the charge current begins to decrease, and the battery full indication is set when the charge current in the CV mode is reduced to the programmed full battery current (1/10).

Charge Termination

A charge cycle is terminated when the charge current falls to 1/10th the ISET programmed value after the final float voltage is reached. This condition is detected by using an internal, filtered comparator to monitor the ISET pin. When the ISET pin voltage falls below 100mV for longer than t_{TERM} (typically 1ms), charging is terminated.

Charge Current Program

The charge current (I_{BAT}) is set by a resistor (R_{ISET}) connecting from the ISET pin to GND. The relationship of the charge current and the programming resistance is established by the following equations ($V_{ISET}=1V$).

$$I_{BAT} = \frac{1700 \times V_{ISET}}{R_{ISET}}$$

Automatic Recharge

Once the charge cycle is terminated, the LP28013S continuously monitors the voltage on the BAT pin. A charge cycle restarts when the battery voltage falls below 4.05V (which corresponds to approximately 80% to 90% battery capacity). This ensures that the battery is kept at or near a fully charged condition and eliminates the need for periodic charge cycle initiations.

Charge Status Indicator (CHRG)

After application of a 5V source, the input voltage rises above the UVLO and sleep thresholds ($V_{IN} > V_{BAT} + V_{ASD}$), but is less than OVP ($V_{IN} < V_{OVP}$), CHRG has two different states: strong pull-down (~5mA) and high impedance. The strong pull-down state indicates that the LP28013S is in a charge cycle. When the charger is entered CV mode and once the charge current has reduced to the battery full charge current threshold (I_{TERM}), the CHRG pin will become high impedance.

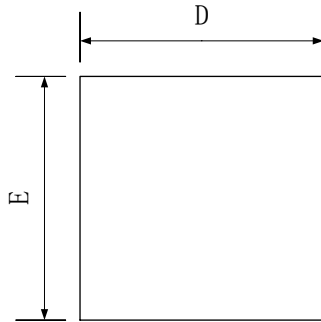
| Function | CHRG |
|---------------|------|
| Charging | Low |
| Charge Finish | Hi-Z |

Thermal Limit

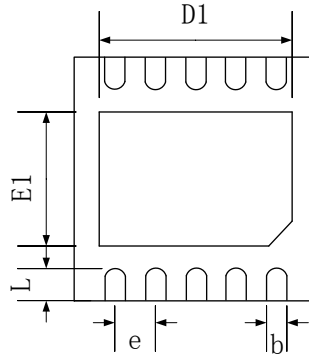
An internal thermal feedback loop reduces charge current if junction temperature attempts to rise above a preset value of approximately 145°C. This feature protects the device from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the device. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

Packaging Information

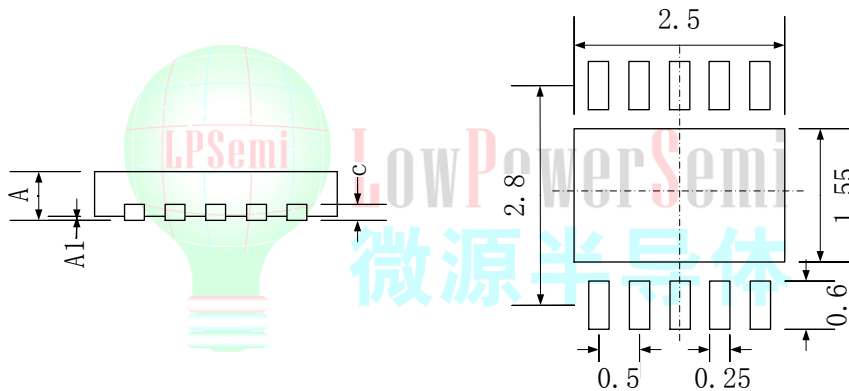
TDFN-10(3*3)



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Recommended Land Pattern

| SYMBOL | MILLIMETER | | |
|--------|------------|------|------|
| | MIN | NOM | MAX |
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0.00 | 0.02 | 0.05 |
| b | 0.18 | 0.25 | 0.30 |
| C | 0.20 REF | | |
| D | 2.90 | 3.00 | 3.10 |
| D1 | 2.40 | 2.50 | 2.60 |
| E | 2.90 | 3.00 | 3.10 |
| E1 | 1.45 | 1.55 | 1.65 |
| e | 0.50 BSC | | |
| L | 0.30 | 0.40 | 0.50 |