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## 7. Bearings for Traction Motors

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Roller bearings are used in all traction motors for electric locomotives and electric cars. Usually, cylindrical roller bearings are utilized due to their high-speed and heavy-load capabilities, as well as their ease of assembly and disassembly. In the case of small motors, deep groove ball bearings may also be used.

### Specification for Traction Motor Bearings

**1. Special consideration must be given to the economical operation of railway vehicles as well as their reliability and safety.**

**2. Traction motor bearings operate under severe conditions such as:**

- › high radial and axial loads
- › high impact loads
- › high speed
- › extended periods of operation without maintenance

**3. NSK uses the following bearing specifications to satisfy the above-noted severe requirements.**

- › Bearing materials are vacuum degassed for high purity.
- › Inner and outer rings are treated for heat dimensional stabilization.
- › Raceway surfaces are always super-finished and the rolling surfaces of rollers are either super-finished or barrel-finished.
- › High load-capacity design is applied for electric locomotives.
- › Tapered ribs and roller end crowning are applied for cylindrical roller bearings to increase the axial load capacity (Fig. 7-1).
- › Roller-guided cages is applied for superior lubrication, temperature rise (Fig. 7-2), etc.
- › High-strength cages are applied, particularly with means to prevent loosening of rivets due to vibration and impacts.
- › Outside surface and both end faces of outer ring are coated with ceramic or heat-resistant resin for prevention of electric pitting.

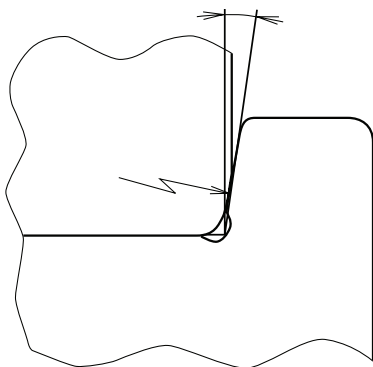


Fig. 7-1 The design of rib and roller end

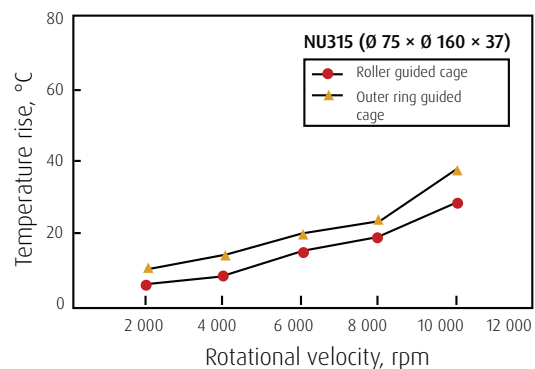


Fig. 7-2 Comparison of temperature rise

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### Insulated Bearings

The most important factor hindering maintenance-free running of traction motor bearings is an occurrence of electric pitting of the bearings. To prevent electric pitting, NSK developed ceramic coating insulated bearings and PPS-resin coating insulated bearings.

Relationship between bearing temperature and insulation resistance of ceramic-insulated bearings was assessed. As a result, no deterioration of insulation resistance up to 110°C was observed. And even above 110°C, 100MΩ of resistance was maintained (Fig. 7-3).

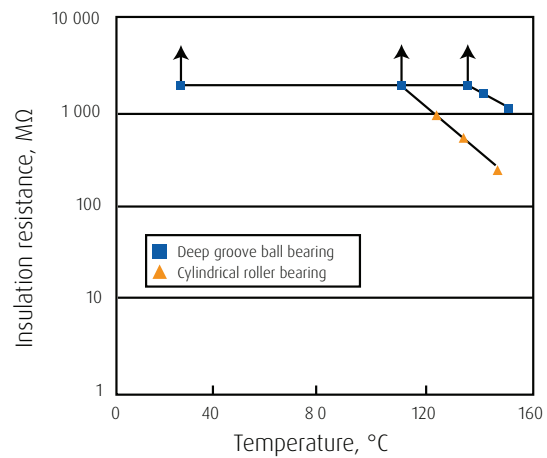


Fig. 7-3 Temperature vs. Insulation resistance

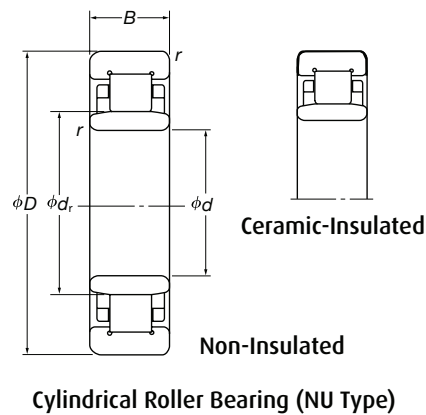


Ceramic Insulated Bearing



PPS Insulated Bearing

## Tables on Bearings for Electric Locomotive Traction Motors



Cylindrical Roller Bearing (NU Type)

### 2xx Series (Free End-Bearings)

| Boundary Dimensions (mm) |     |    |                |         | Basic Numbers | Internal Design <sup>(1)</sup> | Basic Dynamic Load Rating (N) | Basic Static Load Rating (N) | Mass (kg) approx. |
|--------------------------|-----|----|----------------|---------|---------------|--------------------------------|-------------------------------|------------------------------|-------------------|
| d                        | D   | B  | d <sub>r</sub> | r (min) |               |                                |                               |                              |                   |
| 120                      | 215 | 40 | 143.5          | 2.1     | NU224         | E                              | 320,000                       | 395,000                      | 6.3               |
| 130                      | 230 | 40 | 153.5          | 3.0     | NU226         | E                              | 345,000                       | 425,000                      | 7.9               |

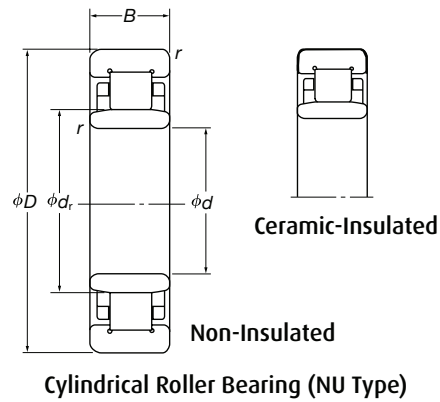
Note (1) E: High-Capacity

### 3xx Series (Free End-Bearings)

| Boundary Dimensions (mm) |     |    |                |         | Basic Numbers | Internal Design <sup>(1)</sup> | Basic Dynamic Load Rating (N) | Basic Static Load Rating (N) | Mass (kg) approx. |
|--------------------------|-----|----|----------------|---------|---------------|--------------------------------|-------------------------------|------------------------------|-------------------|
| d                        | D   | B  | d <sub>r</sub> | r (min) |               |                                |                               |                              |                   |
| 90                       | 190 | 43 | 113.5          | 3       | NU318         | E                              | 315,000                       | 355,000                      | 6.1               |
| 100                      | 215 | 47 | 127.5          | 3       | NU320         | E                              | 380,000                       | 425,000                      | 8.6               |
| 110                      | 240 | 50 | 143.0          | 3       | NU322         | E                              | 425,000                       | 485,000                      | 11.5              |
| 120                      | 260 | 55 | 154.0          | 3       | NU324         | E                              | 530,000                       | 610,000                      | 15.0              |
| 130                      | 280 | 58 | 165.0          | 4       | NU326         | B                              | 655,000                       | 795,000                      | 18.8              |
|                          |     |    | 167.0          |         |               | E                              | 615,000                       | 735,000                      | 18.2              |
| 140                      | 300 | 62 | 180.0          | 4       | NU328         | E                              | 665,000                       | 795,000                      | 22.3              |
|                          |     |    | 178.0          |         |               | F                              | 705,000                       | 860,000                      | 22.9              |
| 150                      | 320 | 65 | 193.0          | 4       | NU330         | E                              | 760,000                       | 920,000                      | 27.1              |
|                          |     |    | 193.0          |         |               | EA                             | 715,000                       | 855,000                      | 26.8              |
|                          |     |    | 190.5          |         |               | J                              | 800,000                       | 985,000                      | 27.3              |
|                          |     |    | 190.0          |         |               | L                              | 790,000                       | 970,000                      | 27.5              |
| 160                      | 340 | 68 | 204.0          | 4       | NU332         | E                              | 860,000                       | 1,050,000                    | 31.5              |
| 180                      | 380 | 75 | 231.0          | 4       | NU336         | E                              | 985,000                       | 1,230,000                    | 43.5              |

Note (1) E, EA: High-Capacity Type B, F, J, L: Specific Types, respectively

## 7. Bearings for Traction Motors



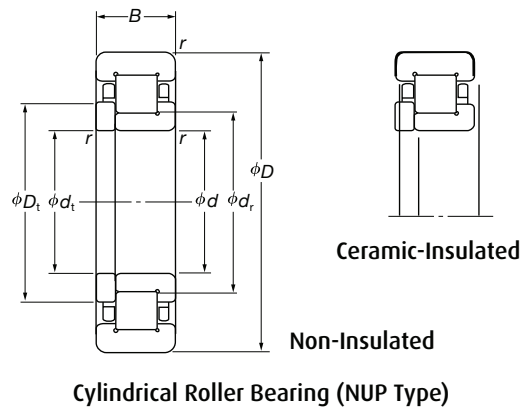
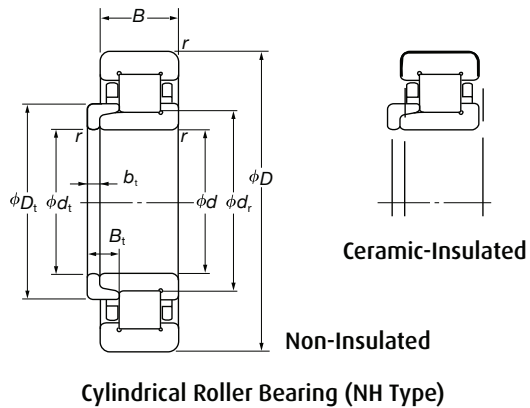
### 4xx Series (Free End-Bearings)

| Boundary Dimensions (mm) |     |    |       |         | Basic Numbers | Internal Design <sup>(1)</sup> | Basic Dynamic Load Rating (N) | Basic Static Load Rating (N) | Mass (kg) approx. |
|--------------------------|-----|----|-------|---------|---------------|--------------------------------|-------------------------------|------------------------------|-------------------|
| d                        | D   | B  | $d_r$ | r (min) |               |                                |                               |                              |                   |
| 90                       | 225 | 54 | 123.5 | 4       | NU418         | -                              | 375,000                       | 400,000                      | 11.5              |
| 105                      | 260 | 60 | 144.5 | 4       | NU421         | -                              | 495,000                       | 555,000                      | 17.3              |
| 160                      | 400 | 88 | 226.0 | 5       | NU432         | -                              | 1,000,000                     | 1,220,000                    | 61.3              |

### 22xx Series (Free End-Bearings)

| Boundary Dimensions (mm) |     |    |       |         | Basic Numbers | Internal Design <sup>(1)</sup> | Basic Dynamic Load Rating (N) | Basic Static Load Rating (N) | Mass (kg) approx. |
|--------------------------|-----|----|-------|---------|---------------|--------------------------------|-------------------------------|------------------------------|-------------------|
| d                        | D   | B  | $d_r$ | r (min) |               |                                |                               |                              |                   |
| 100                      | 180 | 46 | 119   | 2.1     | NU2220        | EA                             | 320,000                       | 425,000                      | 5.3               |

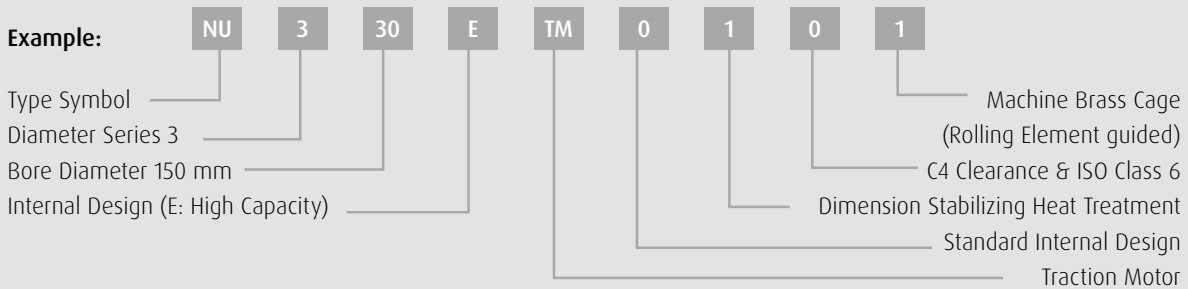
Note (1) EA: High-Capacity Type



| Boundary Dimensions (mm) |     |    |                |                |                |                |         | Basic Numbers | Internal Design <sup>(1)</sup> | Basic Dynamic Load Rating (N) | Basic Static Load Rating (N) | Mass (kg) approx. |
|--------------------------|-----|----|----------------|----------------|----------------|----------------|---------|---------------|--------------------------------|-------------------------------|------------------------------|-------------------|
| d, d <sub>t</sub>        | D   | B  | d <sub>r</sub> | D <sub>t</sub> | B <sub>t</sub> | b <sub>t</sub> | r (min) |               |                                |                               |                              |                   |
| 60                       | 130 | 31 | 77.0           | 84.2           | 15.5           | 9.0            | 2.1     | NH312         | —                              | 124,000                       | 126,000                      | 2.3               |
| 65                       | 140 | 33 | 83.5           | 91.0           | 17.0           | 10.0           | 2.1     | NH313         | —                              | 143,000                       | 151,000                      | 2.9               |
| 70                       | 150 | 35 | 90.0           | 98.0           | 17.5           | 10.0           | 2.1     | NH314         | —                              | 158,000                       | 168,000                      | 3.4               |
| 75                       | 160 | 37 | 95.5           | 104.2          | 16.5           | 11.0           | 2.1     | NH315         | E                              | 240,000                       | 263,000                      | 4.2               |
| 75                       | 160 | 37 | 95.0           | 104.2          | —              | —              | 2.1     | NUP315        | E                              | 240,000                       | 263,000                      | 3.9               |
| 80                       | 170 | 39 | 101.0          | 111.8          | 17.0           | 11.0           | 2.1     | NH316         | E                              | 256,000                       | 282,000                      | 5.0               |
| 90                       | 190 | 43 | 115.0          | 125.0          | 21.0           | 12.0           | 3.0     | NH318         | —                              | 240,000                       | 265,000                      | 6.8               |
|                          |     |    | 113.5          | 124.2          | 18.5           |                |         |               | E                              | 315,000                       | 355,000                      | 6.8               |
| 90                       | 190 | 43 | 115.0          | 125.0          | —              | —              | 3.0     | NUP318        | B                              | 240,000                       | 265,000                      | 6.3               |
|                          |     |    | 113.5          | 124.2          | —              |                |         |               | E                              | 315,000                       | 355,000                      | 6.3               |
| 100                      | 215 | 47 | 129.5          | 140.5          | 22.5           | 13.0           | 3.0     | NH320         | A                              | 310,000                       | 355,000                      | 9.5               |
|                          |     |    | 129.5          | 140.5          | 22.5           |                |         |               | B                              | 310,000                       | 355,000                      | 9.5               |
|                          |     |    | 127.5          | 139.0          | 20.5           |                |         |               | E                              | 380,000                       | 425,000                      | 9.6               |
| 110                      | 240 | 50 | 143.0          | 155.0          | 22.0           | 14.0           | 3.0     | NH322         | E                              | 425,000                       | 485,000                      | 12.9              |
| 120                      | 260 | 55 | 154.0          | 168.5          | 23.5           | 14.0           | 3.0     | NH324         | —                              | 475,000                       | 550,000                      | 16.6              |
| 130                      | 280 | 58 | 167.0          | 182.0          | 24.0           | 14.0           | 4.0     | NH326         | —                              | 560,000                       | 665,000                      | 20.2              |
|                          |     |    | 181.0          | 181.0          | —              |                |         |               | E                              | 615,000                       | 735,000                      | 20.1              |
| 140                      | 300 | 62 | 180.0          | 196.0          | 26.0           | 15.0           | 4.0     | NH328         | —                              | 615,000                       | 745,000                      | 24.7              |

Note (1) E: High-Capacity Type A, B: Specific Types, respectively

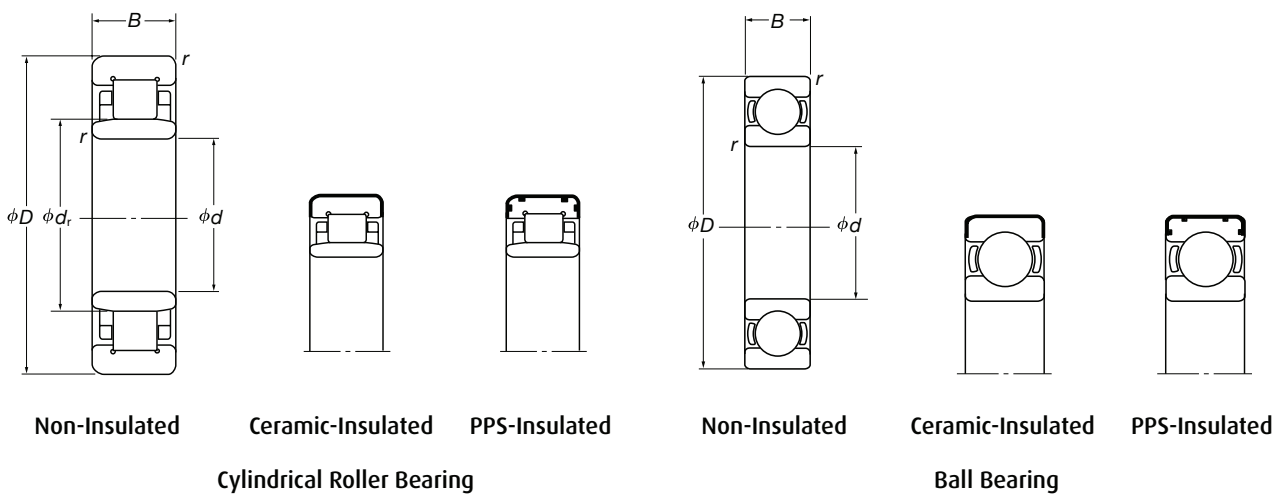
### Standard Number of Cylindrical Roller Bearings



Remarks : For cylindrical roller bearings for traction motors not listed above, please contact NSK.

# 7. Bearings for Traction Motors

Table on Bearings for Electric Car Traction Motors



| Loaded Side, Cylindrical Roller Bearings | Boundary Dimensions (mm) |     |    |                |         | Non-Loaded Side, Ball Bearings | Boundary Dimensions (mm) |     |    |         |
|--|--------------------------|-----|----|----------------|---------|--------------------------------|--------------------------|-----|----|---------|
|  | d                        | D   | B  | d <sub>r</sub> | r (min) |                                | d                        | D   | B  | r (min) |
| NU212                                    | 60                       | 110 | 22 | 73.5           | 1.5     | 6310                           | 50                       | 110 | 27 | 2       |
| NU312                                    | 60                       | 130 | 31 | 77.0           | 2.1     | 6310                           | 50                       | 110 | 27 | 2       |
| NU213                                    | 65                       | 120 | 23 | 79.6           | 1.5     | 6310                           | 50                       | 110 | 27 | 2       |
| NU313                                    | 65                       | 140 | 33 | 83.5           | 2.1     | 6311                           | 55                       | 120 | 29 | 2       |
| NU214                                    | 70                       | 125 | 24 | 84.5           | 1.5     | 6310                           | 50                       | 110 | 27 | 2       |
|  |                          |     |    |                |         | 6311                           | 55                       | 120 | 29 | 2       |
| NU314                                    | 70                       | 150 | 35 | 90.0           | 2.1     | 6311                           | 55                       | 120 | 29 | 2       |
|  |                          |     |    |                |         | 6311                           | 55                       | 120 | 29 | 2       |
| NU215                                    | 75                       | 130 | 25 | 88.5           | 1.5     | 6311                           | 55                       | 120 | 29 | 2       |
|  |                          |     |    |                |         | 6312                           | 60                       | 130 | 31 | 2.1     |
| NU315                                    | 75                       | 160 | 37 | 95.5           | 2.1     | 6311                           | 55                       | 120 | 29 | 2       |
|  |                          |     |    |                |         | 6312                           | 60                       | 130 | 31 | 2.1     |
|  |                          |     |    |                |         | 6314                           | 70                       | 150 | 35 | 2.1     |
| NU415                                    | 75                       | 190 | 45 | 104.5          | 3.0     | 6313                           | 65                       | 140 | 33 | 2.1     |
| NU216                                    | 80                       | 140 | 26 | 95.3           | 2.0     | 6312                           | 60                       | 130 | 31 | 2.1     |
| NU316                                    | 80                       | 170 | 39 | 103.0          | 2.1     | 6312                           | 60                       | 130 | 31 | 2.1     |
| NU416                                    | 80                       | 200 | 48 | 110.0          | 3.0     | 6313                           | 65                       | 140 | 33 | 2.1     |
| NU217                                    | 85                       | 150 | 28 | 101.8          | 2.0     | 6217                           | 85                       | 150 | 28 | 2       |
| NU218                                    | 90                       | 160 | 30 | 107.0          | 2.0     | 6218                           | 90                       | 160 | 30 | 2       |
| NU219                                    | 95                       | 170 | 32 | 113.5          | 2.1     | 6219                           | 95                       | 170 | 32 | 2.1     |

## Interchangeability of Traction Motor Bearings

|  | NSK Bearing Numbers <sup>(1)</sup> | Internal Clearance | Tolerance Class | Other Maker's Numbers (SKF) |
|--|------------------------------------|--------------------|-----------------|-----------------------------|
| Loaded-Side Bearings (Free End-Bearings) NU3xx Series      | NU315E-TM0102                      | C4                 | P6              | NU315ECMC4VA301             |
|  | NU316E-TM0101                      | C4                 | P6              | NU316ECMC4VA301             |
|  | NU317E-TM0101                      | C4                 | P6              | NU317ECMC4VA301             |
|  | NU318E-TM0101                      | C4                 | P6              | NU318ECMC4VA301             |
|  | NU320E-TM0102                      | C4                 | P6              | NU320ECMC4VA301             |
|  | NU322E-TM0101                      | C4                 | P6              | NU322ECMC4VA301             |
|  | NU324E-TM0102                      | C4                 | P6              | NU324ECMC4VA301             |
|  | NU326B-TM0113                      | CG185              | P6A             | 468540VAS                   |
|  | NU326E-TM0101                      | C4                 | P6              | NU326ECMC4VA301             |
|  | NU328E-TM0102                      | C4                 | P6              | NU328ECMC4VA301             |
|  | NU330E-TM0101                      | C4                 | P6              | NU330ECMC4VA301             |
|  | NU330E-TM1105                      | C4                 | P6              | NU330ECMRDC4VA301           |
|  | NU330J-TM0111                      | CG205              | P6              | 466830M/W23                 |
|  | NU332E-TM0101                      | C4                 | P6              | NU332ECMC4VA301             |
| NU332EH2 <sup>(2)</sup> -TM0101                            | C4                                 | P6                 | NU332ECMC4VA309 |                             |
| Non-Loaded Side-Bearings (Fixed End-Bearings) NH3xx Series | NH312E-TM0101                      | C4                 | P6              | NH312ECMC4VA301             |
|  | NH313E-TM0101                      | C4                 | P6              | NH313ECMC4VA301             |
|  | NH314E-TM0101                      | C4                 | P6              | NH314ECMC4VA301             |
|  | NH315E-TM0102                      | C4                 | P6              | NH315ECMC4VA301             |
|  | NH316E-TM0101                      | C4                 | P6              | NH316ECMC4VA301             |
|  | NH317E-TM0101                      | C4                 | P6              | NH317ECMC4VA301             |
|  | NH318E-TM0101                      | C4                 | P6              | NH318ECMC4VA301             |
|  | NH320E-TM0102                      | C4                 | P6              | NH320ECMC4VA301             |
|  | NH320B-TM0312                      | CG153              | P6A             | NH320M2/W23B/W83            |
|  | NH320EH2 <sup>(2)</sup> -TM0102    | C4                 | P6              | NH320ECMC4VA309             |
|  | NH322E-TM0101                      | C4                 | P6              | NH322ECMC4VA301             |
|  | NH324E-TM0102                      | C4                 | P6              | NH324ECMC4VA301             |
|  | NH324E-TM0105                      | C4                 | P6              | NH324ECMRDC4VA301           |
|  | NH326E-TM0101                      | C4                 | P6              | NH326ECMC4VA301             |
|  | NH328E-TM0102                      | C4                 | P6              | NH328ECMC4VA301             |

Notes

(1) E: High-Capacity Type B, J: Specific Types, respectively

(2) Ceramic-Insulated Type