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NB2304A

3.3 V Zero Delay Clock Buffer

The NB2304A is a versatile, 3.3 V zero delay buffer designed to distribute high-speed clocks in PC, workstation, datacom, telecom and other high-performance applications. It is available in an 8 pin package. The part has an on-chip PLL which locks to an input clock presented on the REF pin. The PLL feedback is required to be driven to FBK pin, and can be obtained from one of the outputs. The input-to-output propagation delay is guaranteed to be less than 250 ps, and the output-to-output skew is guaranteed to be less than 200 ps.

The NB2304A has two Banks of two outputs each. Multiple NB2304A devices can accept the same input clock and distribute it. In this case, the skew between the outputs of the two devices is guaranteed to be less than 500 ps.

The NB2304A is available in two different configurations (Refer to NB2304A Configurations Table). The NB2304Ax1* is the base part, where the output frequencies equal the reference if there is no counter in the feedback path. The NB2304Ax1H is the high-drive version of the -1 and the rise and fall times on this device are much faster.

The NB2304Ax2 allows the user to obtain REF, 1/2 X and 2X frequencies on each output Bank. The exact configuration and output frequencies depend on which output drives the feedback pin.

Features

- Zero Input – Output Propagation Delay, Adjustable by Capacitive Load on FBK Input
- Multiple Configurations – Refer to NB2304A Configurations Table
- Input Frequency Range: 15 MHz to 133 MHz
- Multiple Low-Skew Outputs
- Output-Output Skew < 200 ps
- Device-Device Skew < 500 ps
- Two Banks of Four Outputs
- Less than 200 ps Cycle-to-Cycle Jitter (-1, -1H, -5H)
- Available in Space Saving, 8 pin 150 mil SOIC Package
- 3.3 V Operation
- Advanced 0.35 μ CMOS Technology
- Industrial Temperature Available
- These are Pb-Free Devices

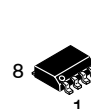
*x = C for Commercial; I for Industrial.



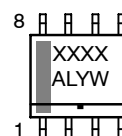
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MARKING DIAGRAM*



**SOIC-8
D SUFFIX
CASE 751**



XXXX = Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb-Free Package

*For additional marking information, refer to Application Note AND8002/D.

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

NB2304A

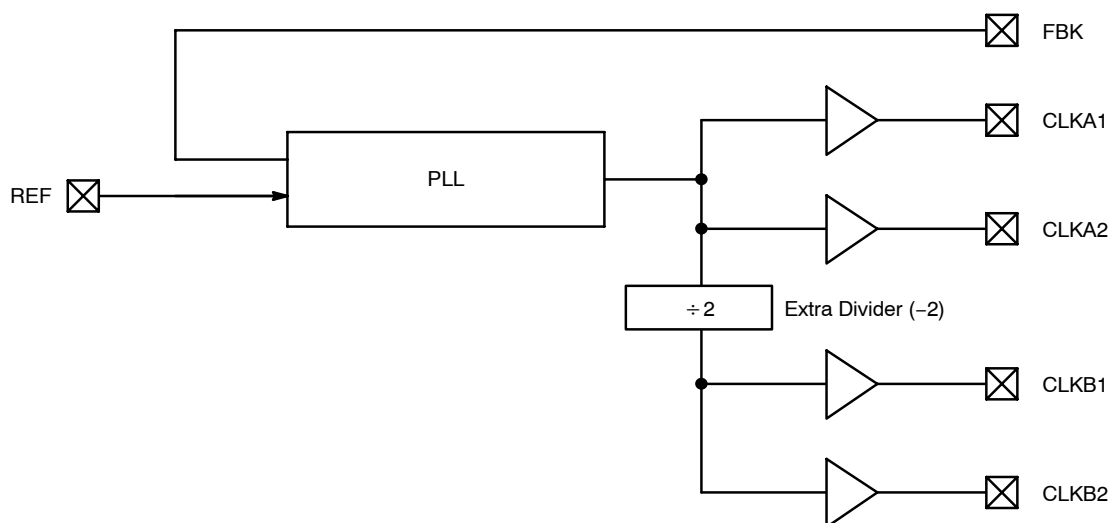


Figure 1. Basic Block Diagram
(see Figures 11 and 12 for device specific Block Diagrams)

Table 1. CONFIGURATIONS (x = C for Commercial; I for Industrial)

| Device | Feedback From | Bank A Frequency | Bank B Frequency |
|------------|------------------|------------------|------------------|
| NB2304Ax1 | Bank A or Bank B | Reference | Reference |
| NB2304Ax1H | Bank A or Bank B | Reference | Reference |
| NB2304Ax2 | Bank A | Reference | Reference ÷ 2 |
| NB2304Ax2 | Bank B | 2 X Reference | Reference |

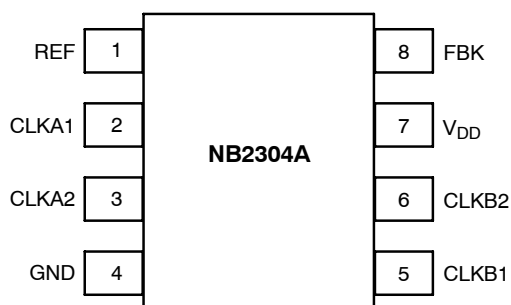


Figure 2. Pin Configuration

Table 2. PIN DESCRIPTION

| Pin # | Pin Name | Description |
|-------|-----------------|--|
| 1 | REF (Note 1) | Input reference frequency, 5 V tolerant input. |
| 2 | CLKA1 (Note 2) | Buffered clock output, Bank A. |
| 3 | CLKA2 (Note 2) | Buffered clock output, Bank A. |
| 4 | GND | Ground. |
| 5 | CLKB1 (Note 2) | Buffered clock output, Bank B. |
| 6 | CLKB2 (Note 2) | Buffered clock output, Bank B. |
| 7 | V _{DD} | 3.3 V supply. |
| 8 | FBK | PLL feedback input. |

1. Weak pulldown.

2. Weak pulldown on all outputs.

NB2304A

Table 3. MAXIMUM RATINGS

| Parameter | Min | Max | Unit |
|---|------|----------------|------|
| Supply Voltage to Ground Potential | -0.5 | +7.0 | V |
| DC Input Voltage (Except REF) | -0.5 | $V_{DD} + 0.5$ | V |
| DC Input Voltage (REF) | -0.5 | 7 | V |
| Storage Temperature | -65 | +150 | °C |
| Maximum Soldering Temperature (10 sec) | | 260 | °C |
| Junction Temperature | | 150 | °C |
| Static Discharge Voltage (per MIL-STD-883, Method 3015) | | > 2000 | V |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

Table 4. OPERATING CONDITIONS FOR COMMERCIAL AND INDUSTRIAL TEMPERATURE DEVICES

| Parameter | Description | Min | Max | Unit |
|-----------|---|-------------------|----------|------|
| V_{DD} | Supply Voltage | 3.0 | 3.6 | V |
| T_A | Operating Temperature (Ambient Temperature) | Commercial -40 | 70 85 | °C |
| C_L | Load Capacitance, 15 MHz to 100 MHz | | 30 | pF |
| C_L | Load Capacitance, from 100 MHz to 133 MHz | | 15 | pF |
| C_{IN} | Input Capacitance (Note 3) | | 7 | pF |

3. Applies to both REF Clock and FBK.

Table 5. ELECTRICAL CHARACTERISTICS FOR COMMERCIAL TEMPERATURE DEVICES

| Parameter | Description | Test Conditions | Min | Max | Unit |
|-----------|---------------------|--|-----|-------|------|
| V_{IL} | Input LOW Voltage | | | 0.8 | V |
| V_{IH} | Input HIGH Voltage | | 2.0 | | V |
| I_{IL} | Input LOW Current | $V_{IN} = 0$ V | | 50.0 | μA |
| I_{IH} | Input HIGH Current | $V_{IN} = V_{DD}$ | | 100.0 | μA |
| V_{OL} | Output LOW Voltage | $I_{OL} = 8$ mA (-1, -2) $I_{OL} = 12$ mA (-1H) | | 0.4 | V |
| V_{OH} | Output HIGH Voltage | $I_{OH} = -8$ mA (-1, -2) $I_{OH} = -12$ mA (-1H) | 2.4 | | V |
| I_{DD} | Supply Current | Unloaded outputs 100 MHz REF Select inputs at V_{DD} or GND | | 45 | mA |
| | | Unloaded outputs, 66 MHz REF (-1, -2) | | 32 | |
| | | Unloaded outputs, 33 MHz REF (-1, -2) | | 18 | |

NB2304A

Table 6. SWITCHING CHARACTERISTICS FOR COMMERCIAL TEMPERATURE DEVICES

| Parameter | Description | Test Conditions | Min | Typ | Max | Unit |
|-------------------|--|--|----------|------|--------------|------|
| t ₁ | Output Frequency | 30 pF load (all devices) 15 pF load (-1, -2) | 15 15 | | 133 133.3 | MHz |
| | Duty Cycle = (t ₂ / t ₁) * 100 (all devices) | Measured at 1.4 V, F _{OUT} = 66.66 MHz 30 pF load | 40.0 | 50.0 | 60.0 | % |
| | | Measured at 1.4 V, F _{OUT} ≤ 50 MHz 15 pF load | 45.0 | 50.0 | 55.0 | |
| t ₃ | Output Rise Time (-1, -2) | Measured between 0.8 V and 2.0 V 30 pF load | | | 2.20 | ns |
| | | Measured between 0.8 V and 2.0 V 15 pF load | | | 1.50 | |
| | Output Rise Time (-1H) | Measured between 0.8 V and 2.0 V 30 pF load | | | 1.50 | |
| t ₄ | Output Fall Time (-1, -2) | Measured between 2.0 V and 0.8 V 30 pF load | | | 2.20 | ns |
| | | Measured between 2.0 V and 0.8 V 15 pF load | | | 1.50 | |
| | Output Fall Time (-1H) | Measured between 2.0 V and 0.8 V 30 pF load | | | 1.25 | |
| t ₅ | Output-to-Output Skew on same Bank (-1, -2) | All outputs equally loaded | | | 200 | ps |
| | Output-to-Output Skew (-1H) | All outputs equally loaded | | | 200 | |
| | Output Bank A-to-Output Bank B Skew (-1) | All outputs equally loaded | | | 200 | |
| | Output Bank A-to-Output Bank B Skew (-2) | All outputs equally loaded | | | 400 | |
| t ₆ | Delay, REF Rising Edge to FBK Rising Edge | Measured at V _{DD} /2 | | 0 | ±250 | ps |
| t ₇ | Device-to-Device Skew | Measured at V _{DD} /2 on the FBK pins of the device | | 0 | 500 | ps |
| t ₈ | Output Slew Rate | Measured between 0.8 V and 2.0 V using Test Circuit #2 | 1 | | | V/ns |
| t _J | Cycle-to-Cycle Jitter (-1, -1H) | Measured at 66.67 MHz, loaded outputs, 15 pF load | | | 175 | ps |
| | | Measured at 66.67 MHz, loaded outputs, 30 pF load | | | 200 | |
| | | Measured at 133.3 MHz, loaded outputs, 15 pF load | | | 100 | |
| | Cycle-to-Cycle Jitter (-2) | Measured at 66.67 MHz, loaded outputs, 30 pF load | | | 400 | ps |
| | | Measured at 66.67 MHz, loaded outputs, 15 pF load | | | 375 | |
| t _{LOCK} | PLL Lock Time | Stable power supply, valid clock presented on REF and FBK pins | | | 1.0 | ms |

NB2304A

Table 7. ELECTRICAL CHARACTERISTICS FOR INDUSTRIAL TEMPERATURE DEVICES

| Parameter | Description | Test Conditions | Min | Max | Unit |
|-----------|---------------------|--|-----|-------|---------------|
| V_{IL} | Input LOW Voltage | | | 0.8 | V |
| V_{IH} | Input HIGH Voltage | | 2.0 | | V |
| I_{IL} | Input LOW Current | $V_{IN} = 0\text{ V}$ | | 50.0 | μA |
| I_{IH} | Input HIGH Current | $V_{IN} = V_{DD}$ | | 100.0 | μA |
| V_{OL} | Output LOW Voltage | $I_{OL} = 8\text{ mA (-1, -2)}$ $I_{OL} = 12\text{ mA (-1H)}$ | | 0.4 | V |
| V_{OH} | Output HIGH Voltage | $I_{OH} = -8\text{ mA (-1, -2)}$ $I_{OH} = -12\text{ mA (-1H)}$ | 2.4 | | V |
| I_{DD} | Supply Current | Unloaded outputs 100 MHz REF Select inputs at V_{DD} or GND | | 45 | mA |
| | | Unloaded outputs, 66 MHz REF (-1, -2) | | 35 | |
| | | Unloaded outputs, 33 MHz REF (-1, -2) | | 20 | |

NB2304A

Table 8. SWITCHING CHARACTERISTICS FOR INDUSTRIAL TEMPERATURE DEVICES

(All parameters are specified with loaded outputs)

| Parameter | Description | Test Conditions | Min | Typ | Max | Unit |
|------------|---|--|----------|------|--------------|------|
| t_1 | Output Frequency | 30 pF load (all devices) 15 pF load (-1, -2) | 15 15 | | 100 133.3 | MHz |
| t_1 | Duty Cycle = $(t_2 / t_1) * 100$ (all devices) | Measured at 1.4 V, $F_{OUT} \leq 66.66$ MHz 30 pF load | 40.0 | 50.0 | 60.0 | % |
| | | Measured at 1.4 V, $F_{OUT} \leq 50$ MHz 15 pF load | 45.0 | 50.0 | 55.0 | |
| t_3 | Output Rise Time (-1, -2) | Measured between 0.8 V and 2.0 V 30 pF load | | | 2.50 | ns |
| | | Measured between 0.8 V and 2.0 V 15 pF load | | | 1.50 | |
| | Output Rise Time (-1H) | Measured between 0.8 V and 2.0 V 30 pF load | | | 1.50 | |
| t_4 | Output Fall Time (-1, -2) | Measured between 2.0 V and 0.8 V 30 pF load | | | 2.50 | ns |
| | | Measured between 2.0 V and 0.8 V 15 pF load | | | 1.50 | |
| | Output Fall Time (-1H) | Measured between 2.0 V and 0.8 V 30 pF load | | | 1.25 | |
| t_5 | Output-to-Output Skew on same Bank (-1, -2) | All outputs equally loaded | | | 200 | ps |
| | Output-to-Output Skew (-1H) | All outputs equally loaded | | | 200 | |
| | Output Bank A-to-Output Bank B skew (-1) | All outputs equally loaded | | | 200 | |
| | Output Bank A-to-Output Bank B skew (-2) | All outputs equally loaded | | | 400 | |
| t_6 | Delay, REF Rising Edge to FBK Rising Edge | Measured at $V_{DD}/2$ | | 0 | ± 250 | ps |
| t_7 | Device-to-Device Skew | Measured at $V_{DD}/2$ on the FBK pins of the device | | 0 | 500 | ps |
| t_8 | Output Slew Rate | Measured between 0.8 V and 2.0 V using Test Circuit #2 | 1 | | | V/ns |
| t_J | Cycle-to-Cycle Jitter (-1, -1H) | Measured at 66.67 MHz, loaded outputs, 15 pF load | | | 180 | ps |
| | | Measured at 66.67 MHz, loaded outputs, 30 pF load | | | 200 | |
| | | Measured at 133.3 MHz, loaded outputs, 15 pF load | | | 100 | |
| | Cycle-to-Cycle Jitter (-2) | Measured at 66.67 MHz, loaded outputs, 30 pF load | | | 400 | ps |
| | | Measured at 66.67 MHz, loaded outputs, 15 pF load | | | 380 | |
| t_{LOCK} | PLL Lock Time | Stable power supply, valid clock presented on REF and FBK pins | | | 1.0 | ms |

NB2304A

Zero Delay and Skew Control

For applications requiring zero input-output delay, all outputs must be equally loaded.

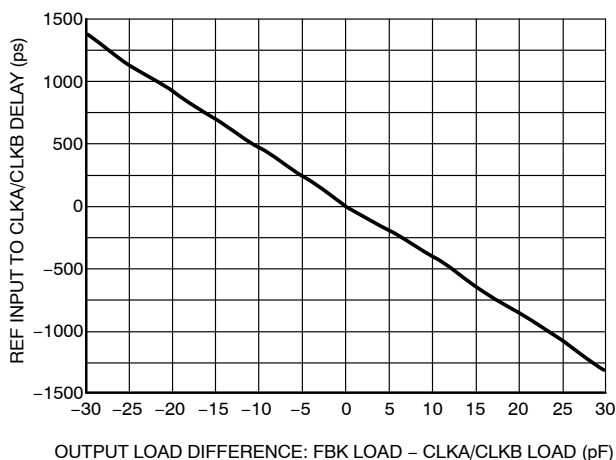


Figure 3. REF Input to CLKA/CLKB Delay vs. Difference in Loading between FBK Pin and CLKA/CLKB Pins

To close the feedback loop of the NB2304A, the FBK pin can be driven from any of the four available output pins. The output driving the FBK pin will be driving a total load of 7 pF plus any additional load that it drives. The relative loading of this output (with respect to the remaining outputs) can adjust the input output delay. This is shown in Figure 3.

For applications requiring zero input-output delay, all outputs including the one providing feedback should be equally loaded. If input-output delay adjustments are required, use Figure 3 to calculate loading differences between the feedback output and remaining outputs. For zero output-output skew, be sure to load outputs equally.

SWITCHING WAVEFORMS

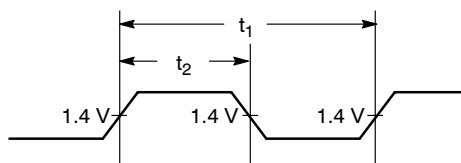


Figure 4. Duty Cycle Timing

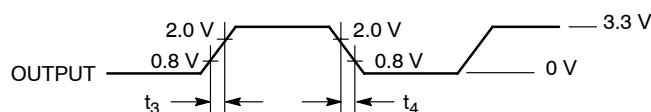


Figure 5. All Outputs Rise/Fall Time

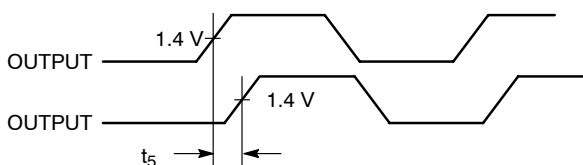


Figure 6. Output - Output Skew

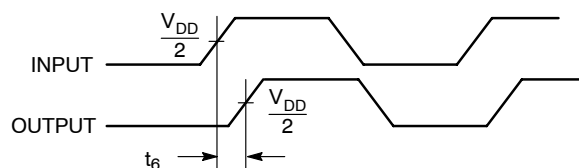


Figure 7. Input - Output Propagation Delay

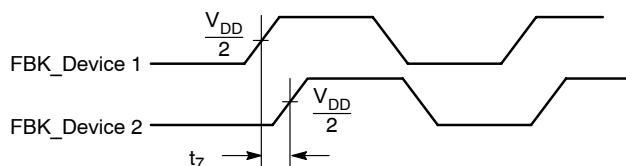


Figure 8. Device - Device Skew

NB2304A

TEST CIRCUITS

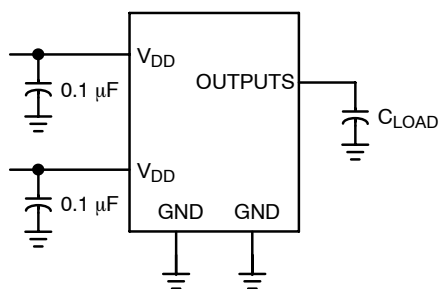


Figure 9. Test Circuit #1

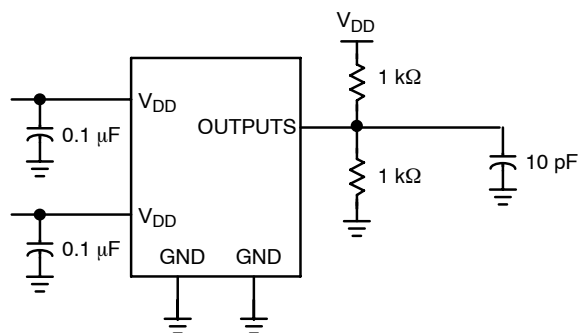


Figure 10. Test Circuit #2
For parameter t_g (output slew rate) on -1H devices

BLOCK DIAGRAMS

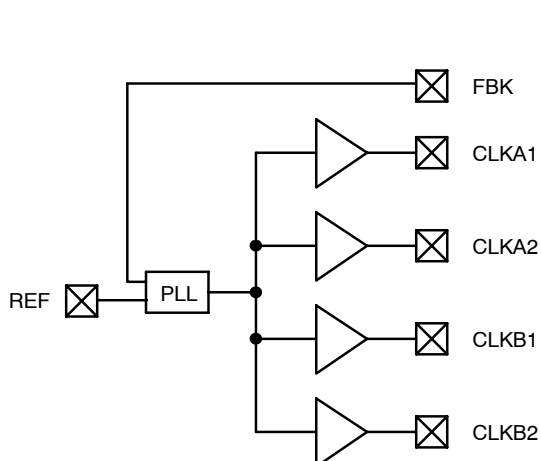


Figure 11. NB2304Ax1 and NB2304Ax1H

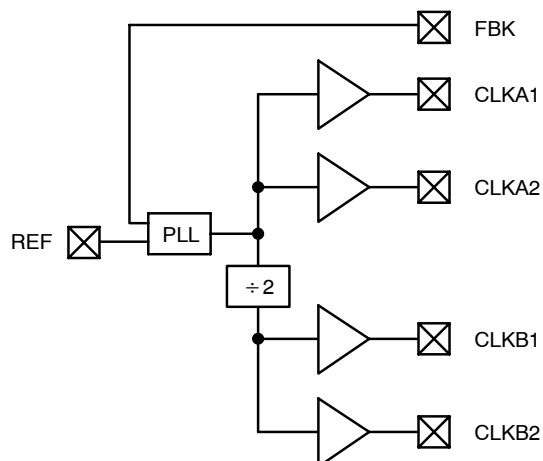


Figure 12. NB2304Ax2

NB2304A

ORDERING INFORMATION

| Device | Marking | Operating Range | Package | Shipping [†] | Availability |
|----------------|---------|-----------------|---------------------|-----------------------|--------------|
| NB2304AC1DG | 4C1 | Commercial | SOIC-8 (Pb-Free) | 98 Units / Rail | <i>Now</i> |
| NB2304AC1DR2G | 4C1 | Commercial | SOIC-8 (Pb-Free) | 2500 Tape & Reel | <i>Now</i> |
| NB2304AI1DG | 4I1 | Industrial | SOIC-8 (Pb-Free) | 98 Units / Rail | <i>Now</i> |
| NB2304AI1DR2G | 4I1 | Industrial | SOIC-8 (Pb-Free) | 2500 Tape & Reel | <i>Now</i> |
| NB2304AC1HDG | 4C1H | Commercial | SOIC-8 (Pb-Free) | 98 Units / Rail | <i>Now</i> |
| NB2304AC1HDR2G | 4C1H | Commercial | SOIC-8 (Pb-Free) | 2500 Tape & Reel | <i>Now</i> |
| NB2304AI1HDG | 4I1H | Industrial | SOIC-8 (Pb-Free) | 98 Units / Rail | <i>Now</i> |
| NB2304AI1HDR2G | 4I1H | Industrial | SOIC-8 (Pb-Free) | 2500 Tape & Reel | <i>Now</i> |
| NB2304AC2DG | 4C2 | Commercial | SOIC-8 (Pb-Free) | 98 Units / Rail | <i>Now</i> |
| NB2304AC2DR2G | 4C2 | Commercial | SOIC-8 (Pb-Free) | 2500 Tape & Reel | <i>Now</i> |
| NB2304AI2DG | 4I2 | Industrial | SOIC-8 (Pb-Free) | 98 Units / Rail | <i>Now</i> |
| NB2304AI2DR2G | 4I2 | Industrial | SOIC-8 (Pb-Free) | 2500 Tape & Reel | <i>Now</i> |

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

NB2304A/D