# XC2401A8167R-G

1.6 GHz Low Noise Amplifier

## ■GENERAL DESCRIPTION

The XC2401A8167R-G is an ultra-low-noise amplifier (LNA) with low operating voltage, low noise figure (NF), low power consumption using CMOS process.

The device offers easy output matching to 50Ω for input and output with less external components.

An internal self bias function eliminates external bias setting.

The device operates at 1.2V. For higher power supplies such as 1.8V and 2.85V, the device can operate with a self bias of one adding resister.

## ■APPLICATIONS

●GPS RF module

## ■FEATURES

| | |
|---|---|
| Noise Figure | : NF=0.69dB(TYP.) (@ 1.575GHz) |
| Low Power Consumption | : 6.6mW (TYP.) @ $V_{DD}$=1.2V, Fixed Bias |
| High Gain | : S21 =15dB(TYP.) (@ 1.575GHz) |
| Operation Voltage Range | : 1.14V～1.26V @ Fixed Bias |
| Output | : CMOS Output, 50Ω driver built-in |
| Operating Ambient Temperature | : -40℃～+85℃ |
| Package | : USPN-4B02 |
| Environmentally Friendly | : EU RoHS Compliant, Pb Free |

## ■TYPICAL APPLICATION CIRCUIT

Figure 1: Fixed Bias

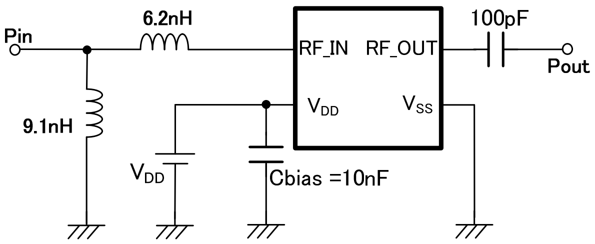
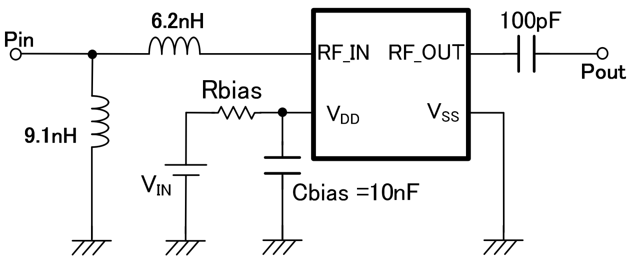


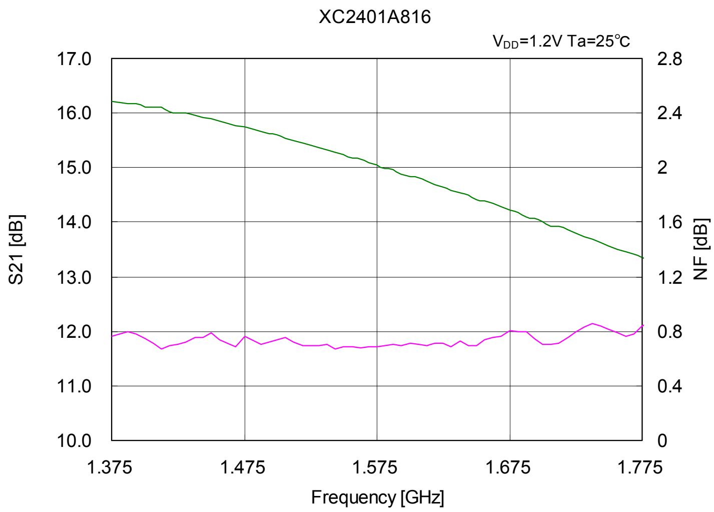

Figure 2: Self Bias



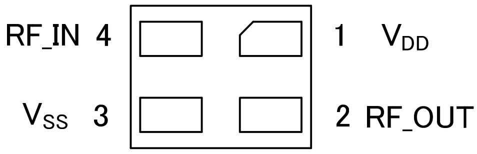

| $V_{IN}$ [V] | Rbias [Ω] |
|---|---|
| 3.00 | 560 |
| 2.85 | 470 |
| 1.80 | 160 |

* $R_{BIAS}$ should be in ±1% tolerance and ±200ppm/℃ temperature stability.

## ■TYPICAL PERFORMANCE CHARACTERISTICS



## ■PIN CONFIGURATION




USPN-4B02
(BOTTOM VIEW)

## ■PIN ASSIGNMENT

| PIN NUMBER<br>USPN-4B02 | PIN NAME | FUNCTION |
|---|---|---|
| 1 | $V_{DD}$ | Power Supply RF |
| 2 | RF_OUT | RF Signal Output |
| 3 | $V_{SS}$ | Ground |
| 4 | RF_IN | RF Signal Input |

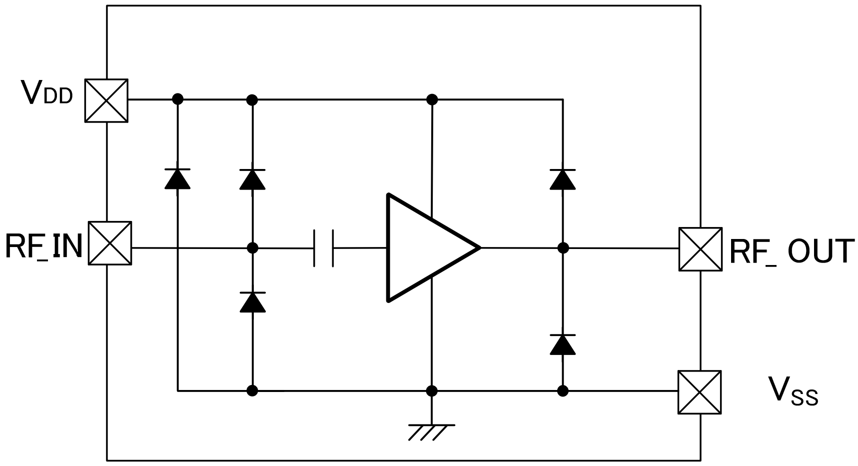
## ■PRODUCT CLASSIFICATION

●Ordering Information

| PRODUCT NAME | PACKAGE | ORDER UNIT |
|---|---|---|
| XC2401A8167R-G (*1) | USPN-4B02 | 5,000/Reel |

(*1) The "-G" suffix denotes Halogen and Antimony free as well as being fully RoHS compliant.

## ■BLOCK DIAGRAM




## ■ABSOLUTE MAXIMUM RATINGS

Ta=25℃

| PARAMETER | SYMBOL | RATINGS | UNITS |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | $V_{SS}$ - 0.3 ～ 1.60 | V |
| Supply Circuit | $I_{DD}$ | 30 | mA |
| RF Input Power | $P_{IN}$ | 10 | dBm |
| RF_IN Input Voltage | RF_IN | $V_{SS}$ - 0.3 ～ $V_{DD}$ + 0.3 | V |
| RF_OUT Input Voltage | RF_OUT | $V_{SS}$ - 0.3 ～ $V_{DD}$ + 0.3 | V |
| Power Dissipation | Pd | 100 | mW |
| Operating Ambient Temperature | Topr | -40～+85 | °C |
| Storage Temperature | Tstg | -55～+125 | °C |

## ■ELECTRICAL CHARACTERISTICS

●DC Characteristics

Fixed Bias (refer to TYPICAL APPLICATION CIRCUIT, Figure 1)

Ta=25℃

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUIT |
|---|---|---|---|---|---|---|---|
| Power Supply Pin Voltage | $V_{DD}$ | - | 1.14 | 1.20 | 1.26 | V | ① |
| Current Circuit | $I_{DD}$ | $V_{DD}$=1.2V | | 5.5 | 10.5 | mA | ① |

Self Bias (refer to TYPICAL APPLICATION CIRCUIT, Figure 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUIT |
|---|---|---|---|---|---|---|---|
| Input Power Supply Voltage 1 | $V_{IN1}$ | Rbias=560Ω±1% ±200ppm/℃ | 2.850 | 3.000 | 3.150 | V | ① |
| Input Power Supply Voltage 2 | $V_{IN2}$ | Rbias=470Ω±1%, ±200ppm/℃ | 2.708 | 2.850 | 2.992 | V | ① |
| Input Power Supply Voltage 3 | $V_{IN3}$ | Rbias=160Ω±1%, ±200ppm/℃ | 1.710 | 1.800 | 1.890 | V | ① |
| Power Supply Pin Voltage | $V_{DD}$ | $V_{IN}$ = $V_{IN1}$, $V_{IN2}$, $V_{IN3}$ | 0.90 | 1.12 | 1.32 | V | ① |
| Current Circuit | $I_{DD}$ | $V_{IN}$ = $V_{IN1}$, $V_{IN2}$, $V_{IN3}$ | - | 4.25 | 5.50 | mA | ① |

* When the device is used in self bias, please use the specified $R_{BIAS}$ and $C_{BIAS}$.

## ■ELECTRICAL CHARACTERISTICS (Continued)

●AC Characteristics $V_{DD}$=1.2V Ta=25℃

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNITS | CIRCUIT |
|---|---|---|---|---|---|---|---|
| Power Gain | S21 | f=1.575 GHz | 11.5 | 15.0 | - | dB | ② |
| Input Return Loss | S11 | f=1.575GHz | - | 6 | - | dB | ② |
| Output Return Loss | S22 | f=1.575GHz | - | 6 | - | dB | ② |
| Isolation | S12 | f=1.575GHz | - | -20 | - | dB | ② |
| Noise Figure (*1) | NF | f=1.575GHz | - | 0.69 | - | dB | ③ |
| Input Power IP3 | $I_{IP3}$ | f=1.575GHz, 1.576GHz<br>Pin = -30dBm | - | -1.0 | - | dBm | ④ |
| Input Power @ 1dB Gain Compression | P1dB | f=1.575GHz | - | -12 | - | dBm | ② |

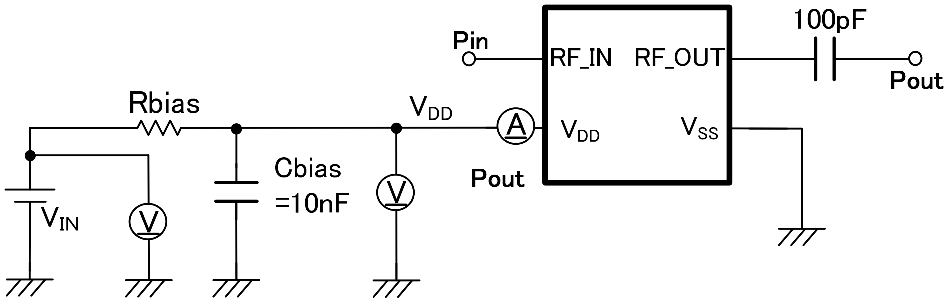
*1: NF is the value excluding the PCB loss.

Note

1. In case symptoms of transient voltage drop and rise temporarily, please use this IC within the stated maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Please eliminate static electricity from the operational table, people, and soldering iron.
3. Please use noiseless power supply for stable operation.
4. Please use ±1% Rbias with ±200ppm/℃ temperature stability and 10nF Cbias.
5. Please connect Cbias to $V_{DD}$ pin as close as possible.
6. Please ensure to use an external component which does not depend on bias or temperature too much.
7. We will improve the product quality and improve reliability, however please make sure to design fail safe or pre-aging treatment on the system.

## ■TEST CIRCUITS

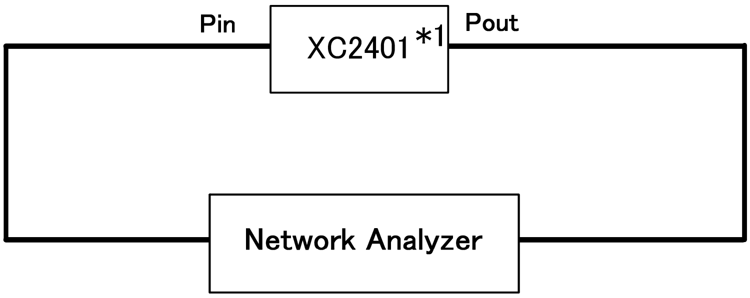
●Circuit ① (DC Characteristics: Power Supply Pin Voltage, Circuit Current, Input Power Supply Voltage)




* Fixed Bias: Rbias=0Ω, $V_{IN}$=$V_{DD}$

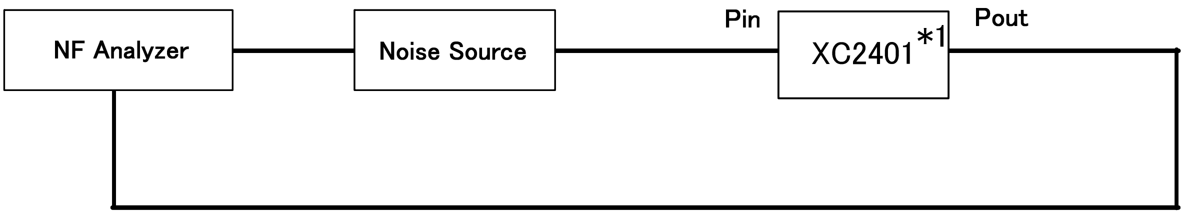
** Pin / Pout is 50Ω

●Circuit ② (Power Gain, Input Return Loss, Output Return Loss, Isolation, Input Power @ 1dB Gain Compression)




*1: Refer to the circuit ⑤ for the block detail.

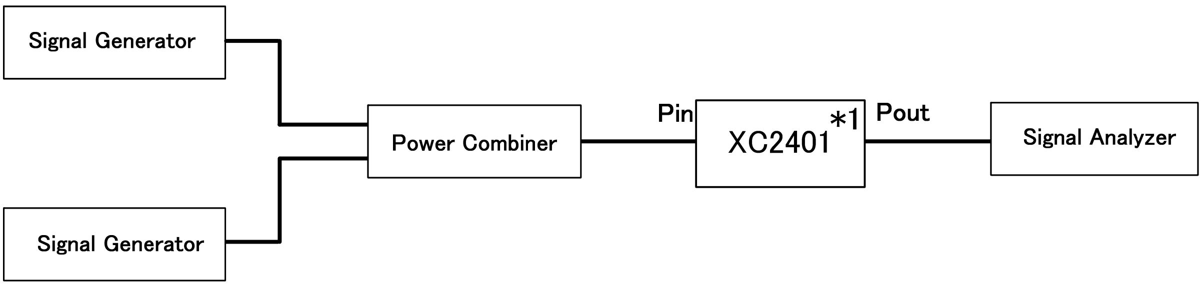
●Circuit ③ (Noise Figure)




*1: Refer to the circuit ⑤ for the block detail.

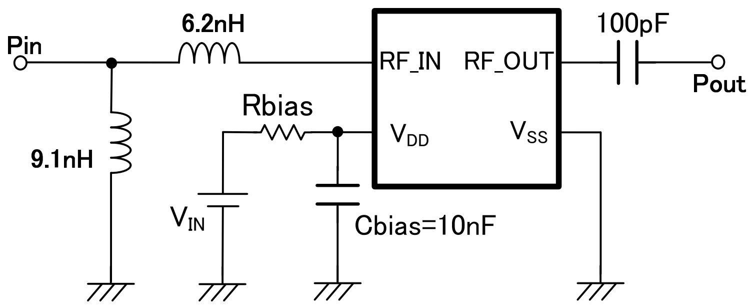
## ■TEST CIRCUITS (Continued)

●Circuit ④ (Input Power IP3)




*1: Refer to the circuit ⑤ for the block detail.

●Circuit ⑤ (XC2401 series, the circuit of the block)

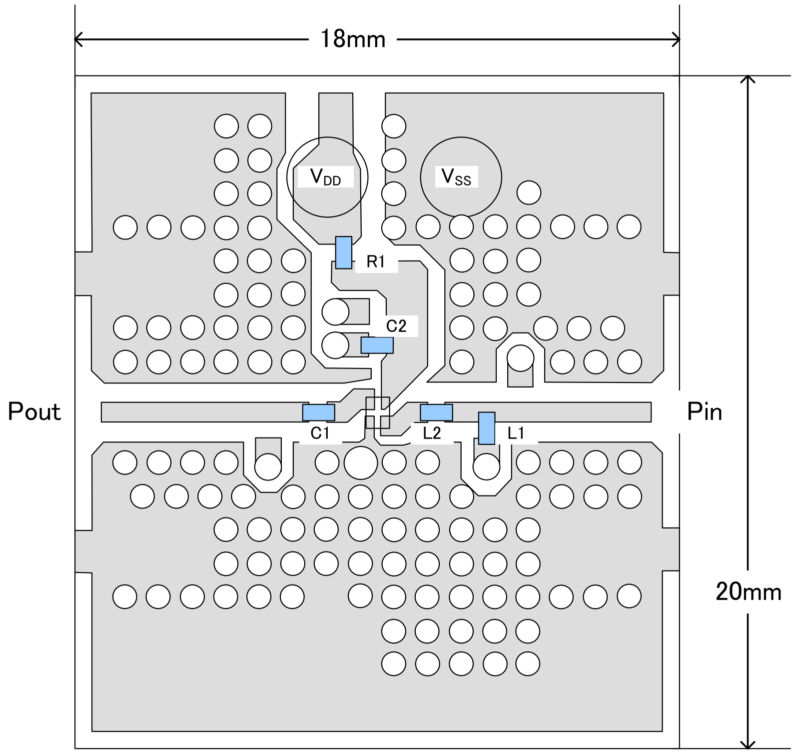



| $V_{IN}$(V) | Rbias(Ω) |
|---|---|
| 3.00 | 560 |
| 2.85 | 470 |
| 1.80 | 160 |

* Fixed Bias: Rbias=0Ω, $V_{IN}$=$V_{DD}$

** Rbias: Should be in ±1% tolerance and ±200ppm/℃ temperature stability.

## ■EVALUATION BOARD



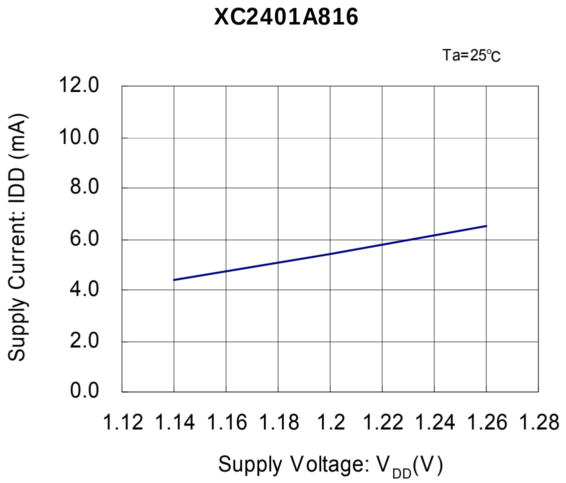

| SYMBOL | SPEC | COMMENT |
|---|---|---|
| C1 | 100pF | MURATA (GRM1552C1H) |
| C2 | 10nF | - |
| L1 | 9.1nH | TDK (GLQ1005type) |
| L2 | 6.2nH | TDK ( GLQ1005type) |
| R1 (Rbias)(*1) | - (*1) | Less than ±1% tolerance, Less than ±200ppm/℃ temperature stability |

PCB(FR-4)
MICROSTRIPLINE WIDTH = 0.6mm
t = 0.018mm
PCB size = 20mm×18mm

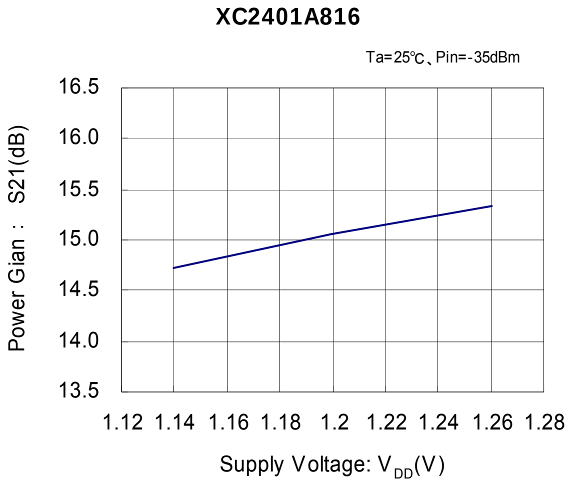
*1: Fixed Bias: Rbias=0Ω
* Please use an external component which does not depend on bias or temperature too much.

# ■TYPICAL PERFORMANCE CHARACTERISTICS

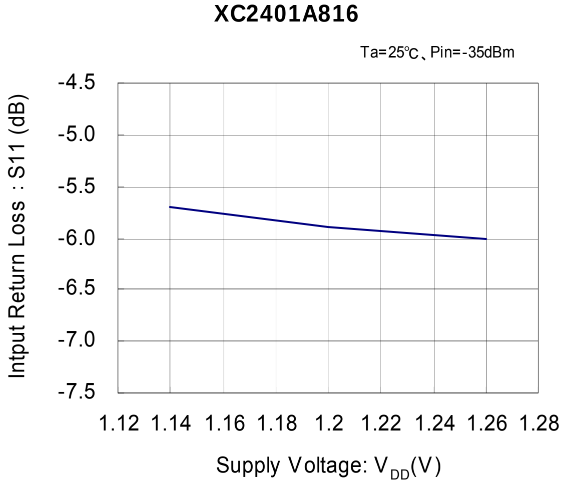
(1) Supply Circuit vs. Supply Voltage



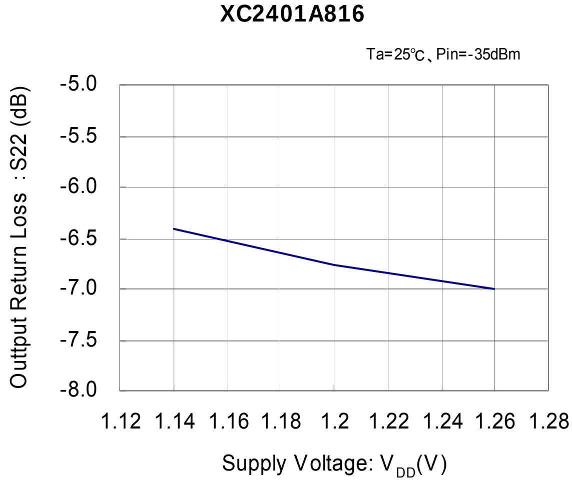

(2) Power Gain vs. Supply Voltage



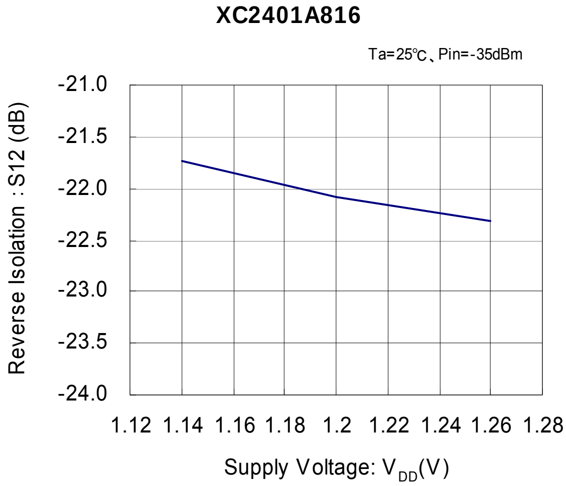

(3) Input Return Loss vs. Supply Voltage



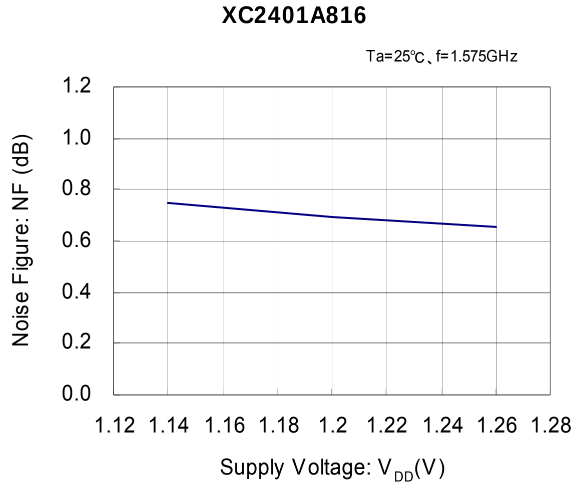

(4) Output Return Loss vs. Supply Voltage




(5) Reverse Isolation vs. Supply Voltage

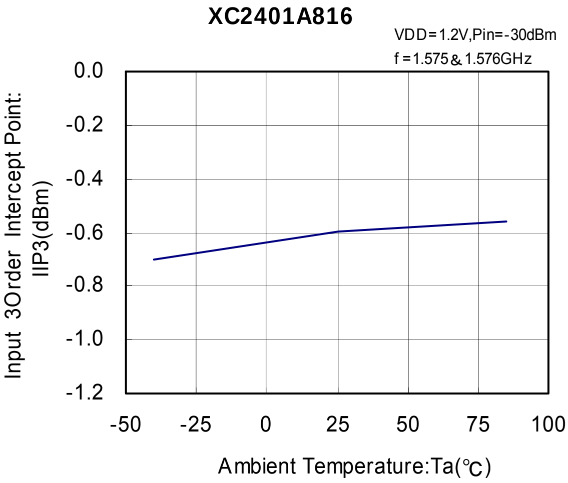



(6) Noise Figure vs. Supply Voltage

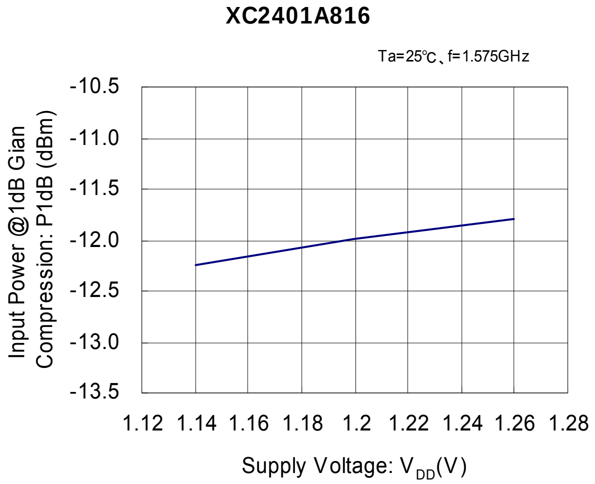


## ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

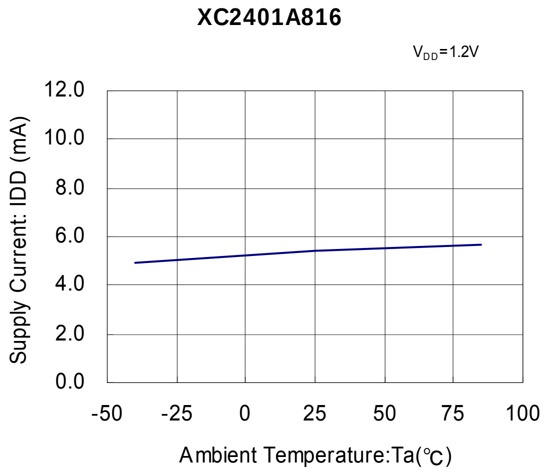
(7) Input 3 Order Intercept Point vs. Supply Voltage



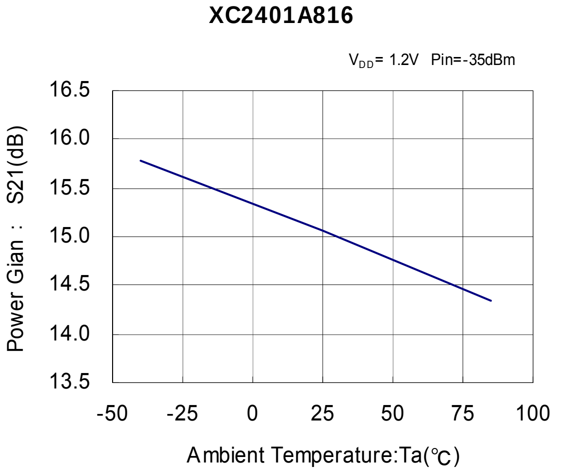

(8) Input Power @ 1dB Gain compression vs. Power Supply Voltage



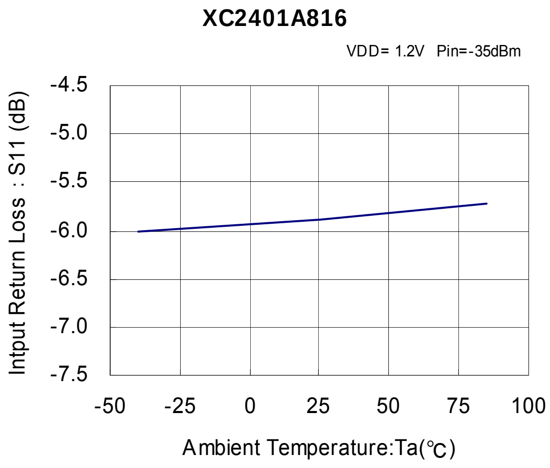

(9) Supply Current vs. Ambient Temperature



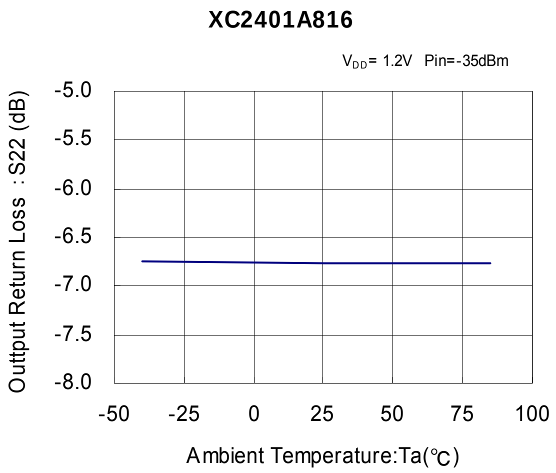

(10) Power Gain vs. Ambient Temperature




(11) Input Return Loss vs. Ambient Temperature

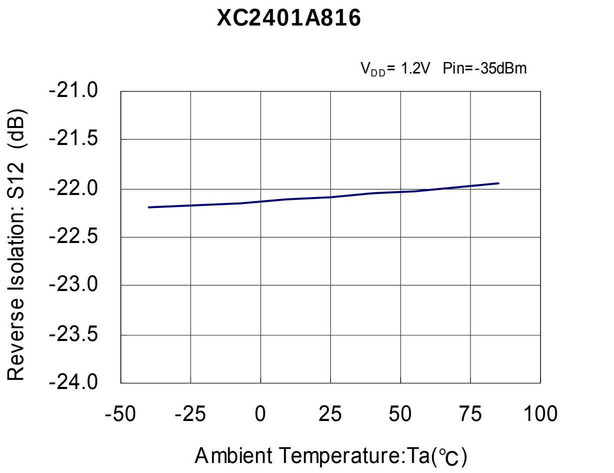



(12) Output Return Loss vs. Ambient Temperature

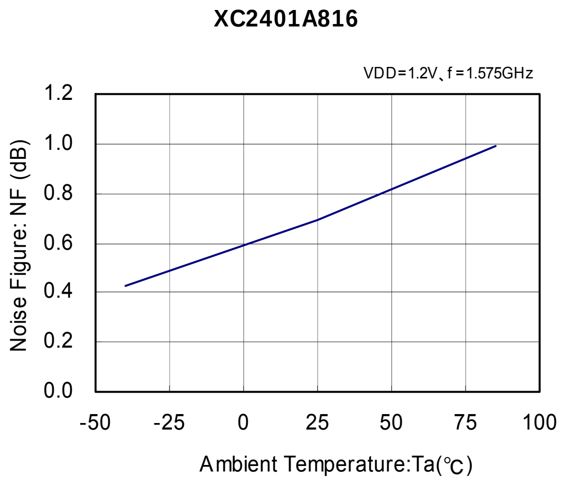


## ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

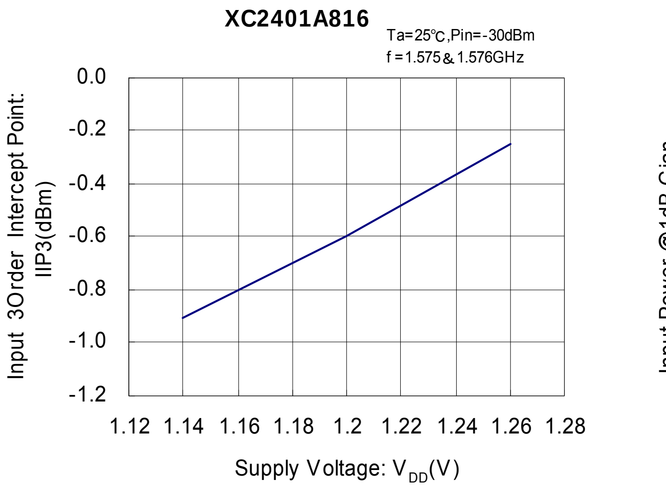
(13) Reverse Isolation vs. Ambient Temperature



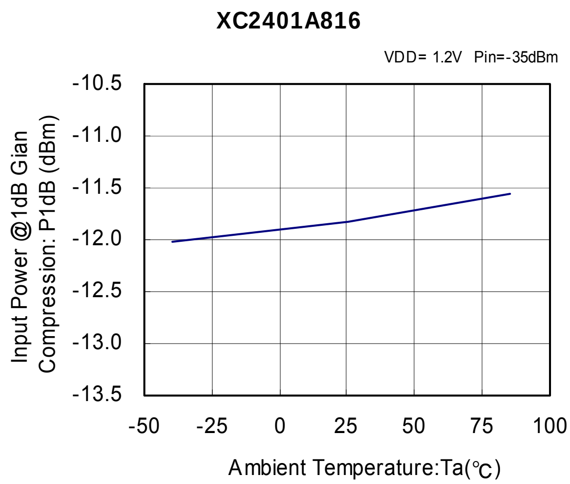

(14) Noise Figure vs. Ambient Temperature



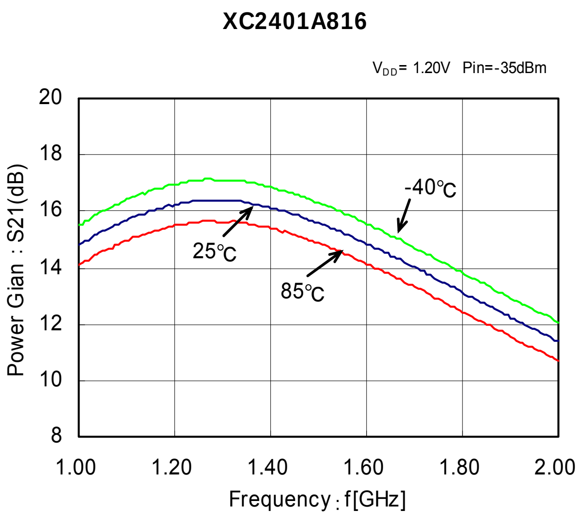

(15) Input 3 Order intercept point vs. Ambient Temperature



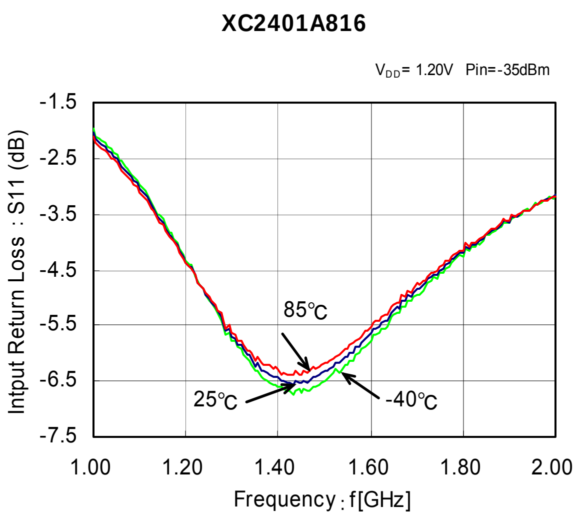

(16) Input Power @ 1dB Gain Compression vs. Ambient Temperature




(17) Power Gain vs. Frequency

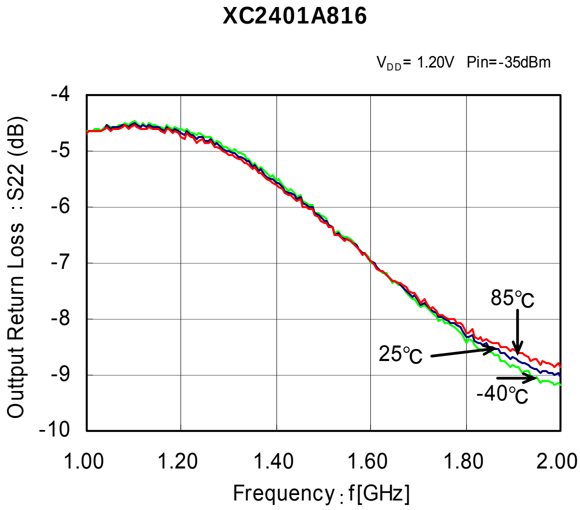



(18) Input Return Loss vs. Frequency

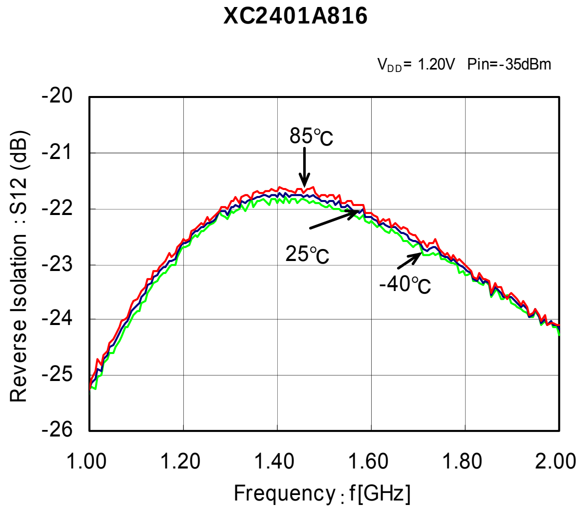


## ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

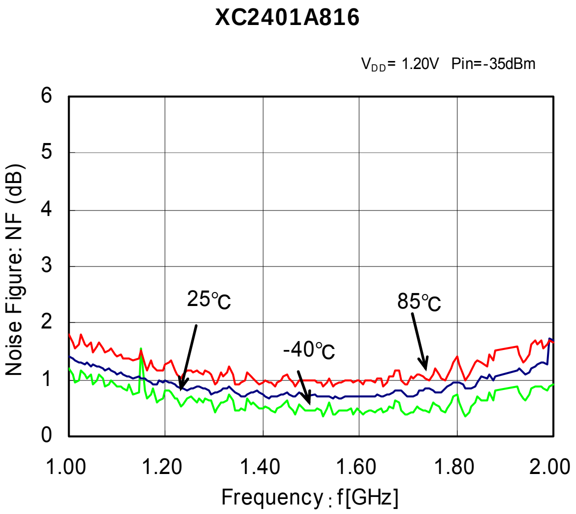
(19) Output Return Loss vs. Frequency



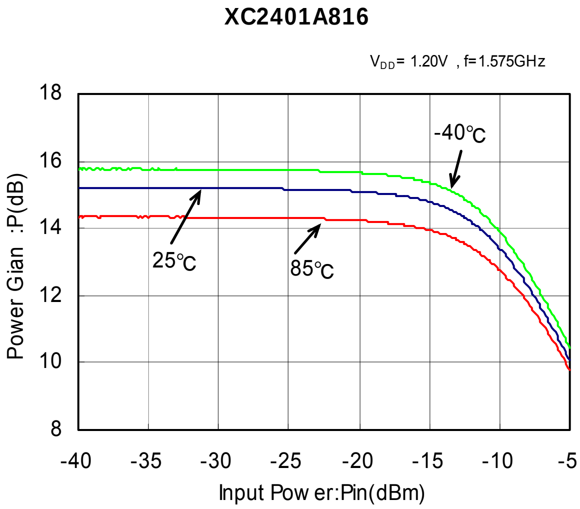

(20) Isolation vs. Frequency



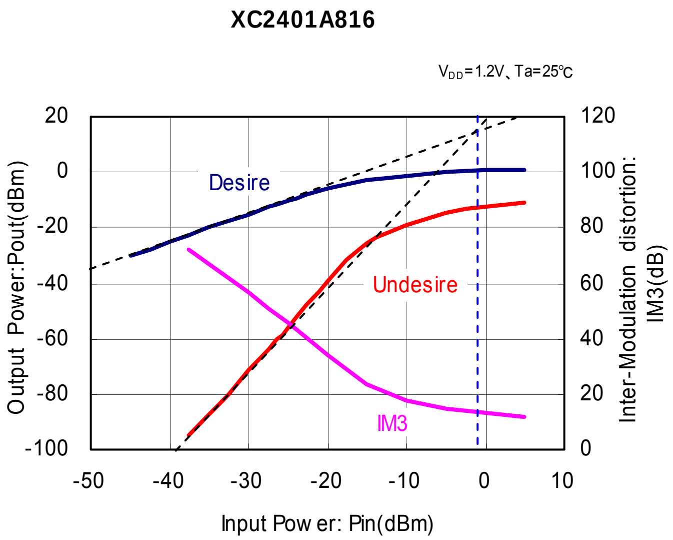

(21) Noise Figure vs. Frequency




(22) Power Gain vs. Input Power




(23) Output Power / IM3 vs. Input Power

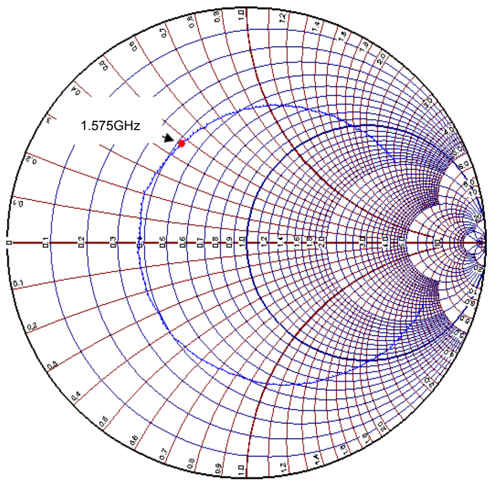


## ■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(24) Input Return Loss vs. Frequency (Smith Chart)

**XC2401A816**

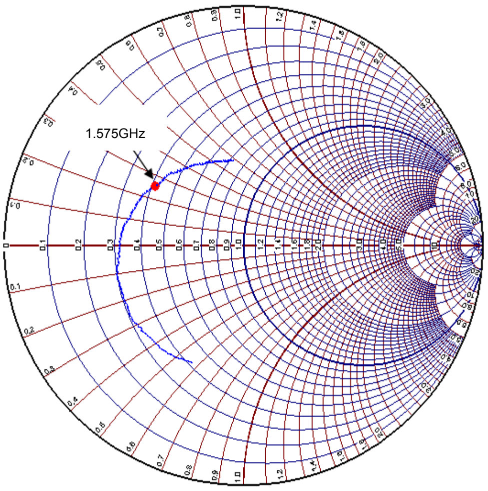
$V_{DD}$=1.2V, Pin=-35dBm




(25) Output Return Loss vs. Frequency (Smith Chart)

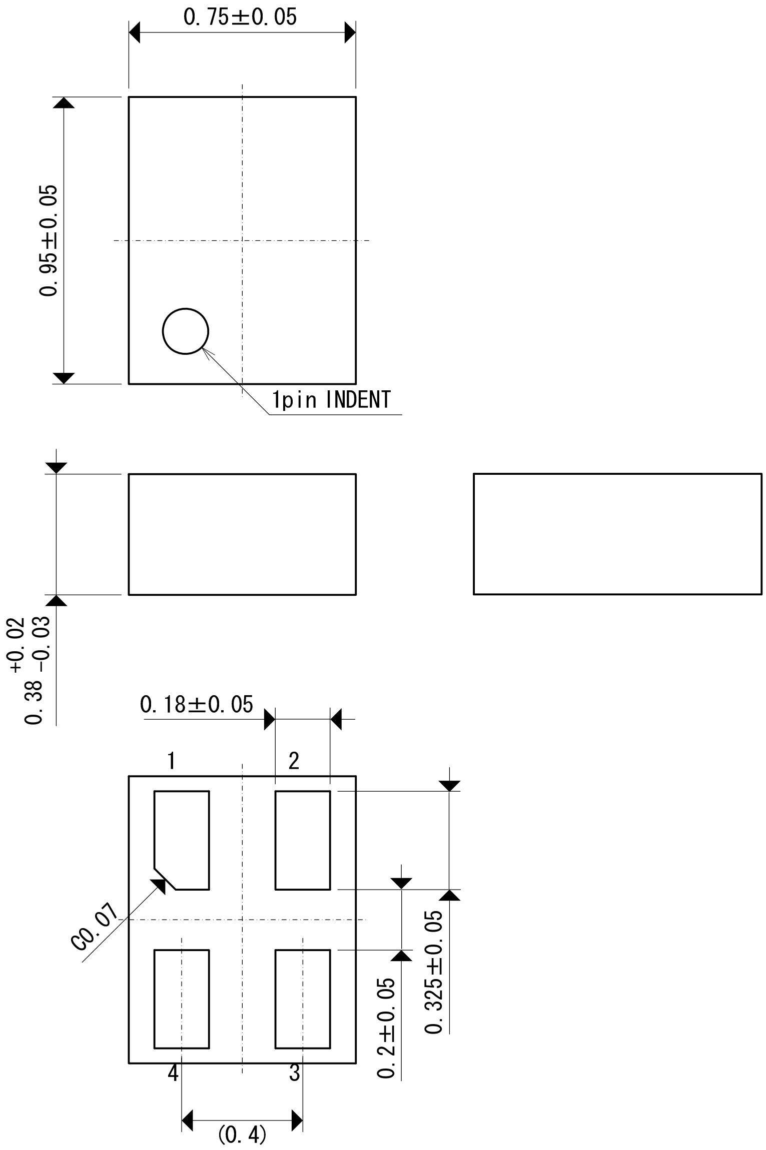
**XC2401A816**

$V_{DD}$=1.2V, Pin=-35dBm



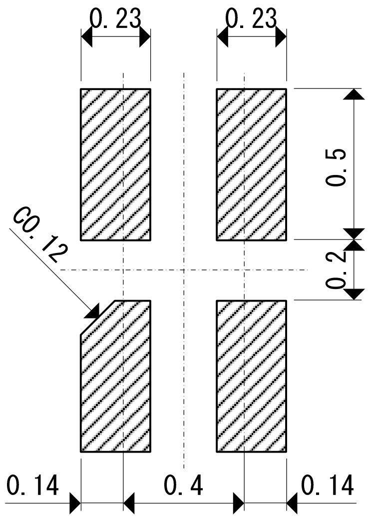
## ■ PACKAGING INFORMATION

●USPN-4B02

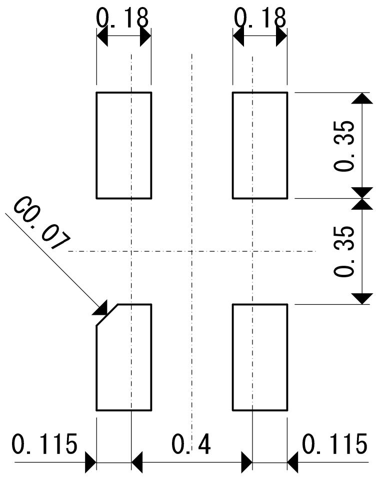


## ■ PACKAGING INFORMATION (Continued)

●USPN-4B02 Reference Pattern Layout

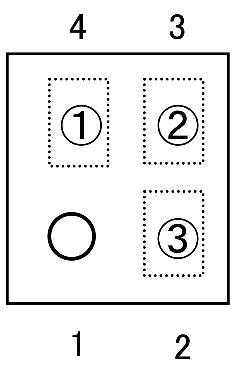



●USPN-4B02 Reference Metal Mask Design




## ■MARKING RULE

USPN-4B02




① represents product series.

| MARK | PRODUCT SERIES |
|---|---|
| 8 | XC2401******-G |

② represents product.

| MARK | PRODUCT SERIES |
|---|---|
| A | XC2401A816**-G |

③ represents production lot number.
01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to Z9, ZA to ZZ in order.
(G, I, J, O, Q, W excepted)
*No character inversion used.

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3. Please ensure suitable shipping controls (including fail-safe designs and aging protection) are in force for equipment employing products listed in this datasheet.
4. The products in this datasheet are not developed, designed, or approved for use with such equipment whose failure of malfunction can be reasonably expected to directly endanger the life of, or cause significant injury to, the user.

   (e.g. Atomic energy; aerospace; transport; combustion and associated safety equipment thereof.)
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