NUF2221W1

USB Upstream Terminator with ESD Protection

This device is designed for applications requiring **Line Termination**, **EMI Filtering** and **ESD Protection**. It is intended for use in upstream USB ports, Cellular phones, Wireless equipment and computer applications. This device offers an integrated solution in a small package (SC−88/SOT−363) reducing PCB space and cost.

Features

- Provides USB Line Termination, Filtering and ESD Protection
- Single IC Offers Cost Savings
- Bi−directional EMI Filtering Prevents Noise from Entering/Leaving the System
- Compliance with IEC61000−4−2 (Level 4)
  - 25 kV (Contact)
  - 30 kV (Air)
- Flexible Pull−up Line Termination to Meet USB 1.1 Low Speed and High Speed Specification
- ESD Ratings: Machine Model = C
  Human Body Model = 3B
- This is a Pb−Free Device

Benefits

- SC−88 Package Minimizes PCB Space
- Integrated Circuit Increases System Reliability versus Discrete Component Implementation
- TVS Devices Provide ESD Protection That is Better than a Discrete Implementation because the Small IC minimizes Parasitic Inductances

Typical Applications

- USB Hubs
- Computer Peripherals Using USB

MAXIMUM RATINGS (T_A = 25°C)

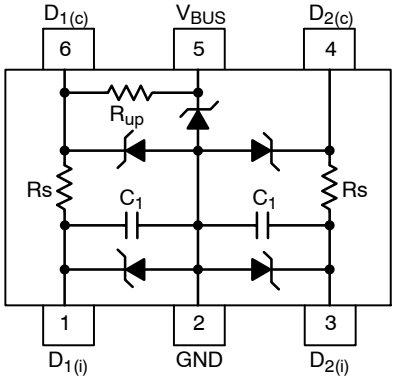
Rating	Symbol	Value	Unit
Steady State Power	P_D	225	mW
Maximum Junction Temperature	$T_{J(max)}$	125	°C
Operating Temperature Range	T_J	−55 to +125	°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Lead Solder Temperature (10 second duration)	T_L	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

ON Semiconductor®

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CIRCUIT DESCRIPTION

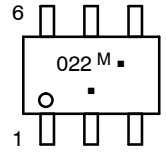




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SC−88 / SOT−363
CASE 419B
PLASTIC

MARKING DIAGRAM



022 = Specific Device Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

Device	R_S (Ω)	Pkg	Shipping†
NUF2221W1T2G	22	SC−88 (Pb−Free)	3000 / Tape & Reel

†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.

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Device	V_{RWM} (Volts)	V_{BR} @ 1 mA (Volts)			I_R @ 3.3 V (nA)			Line Capacitance Vdc = 2.5 V f = 1 MHz pF (Note 1)			Series Resistor R_S (Ω)			Pull−up Resistor R_{up} (kΩ)		
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
NUF2221W1	5.25	5.6	6.8	8.0	–	10	100	37.6	42	56.4	17.6	22	26.4	1.2	1.5	1.8

1. Measured between pins 1, 3, 4, 6 and ground with pin 5 also grounded.
2. For other resistance values (e.g. 15 Ω, 33 Ω), please contact your local ON Semiconductor sales representative.

TYPICAL CHARACTERISTICS

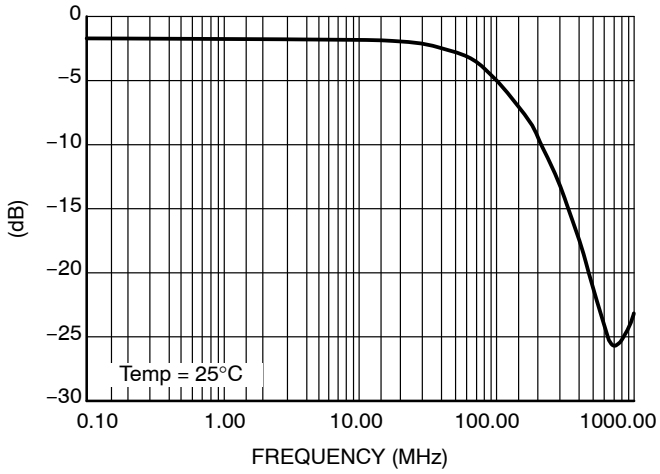


Figure 1. Insertion Loss Characteristics

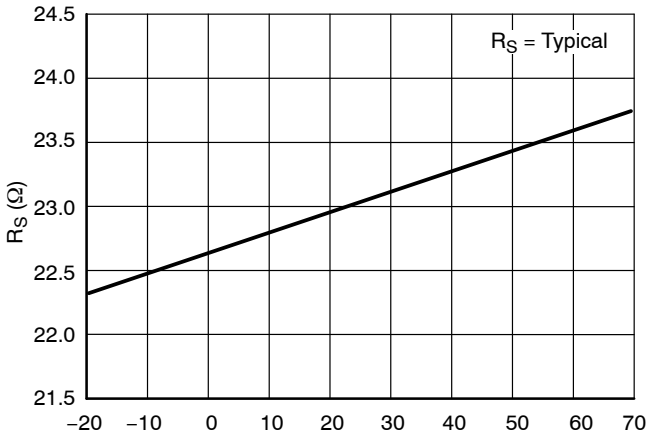


Figure 2. R_S versus Temperature

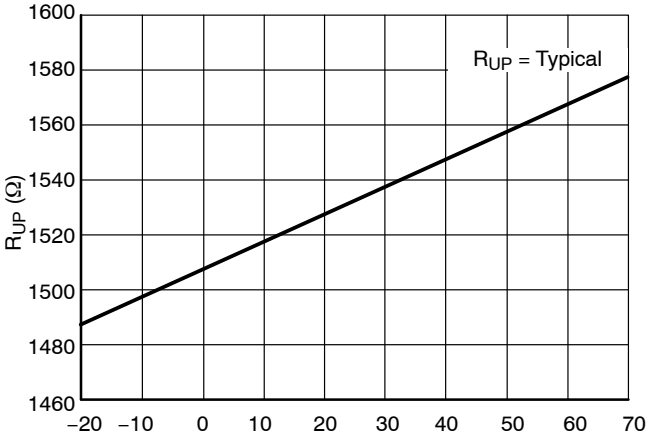


Figure 3. R_{UP} versus Temperature

APPLICATIONS BACKGROUND

What is USB?

The USB is not a serial port, it is a serial bus, a fact that enables a single port on the computer to be a link for a myriad of devices, (up to 127 devices in a USB system). We can easily chain one device to another and use one port as a connecting point of many devices by using a hub. All these enable us to look at the USB system as a small network of devices.

The Universal Serial Bus (USB) makes connecting devices to your computer faster, easier and virtually limitless. High−Speed USB devices are capable of communicating at speeds up to 12 megabytes−without shutting down and without having to open your computer.

Typical USB System

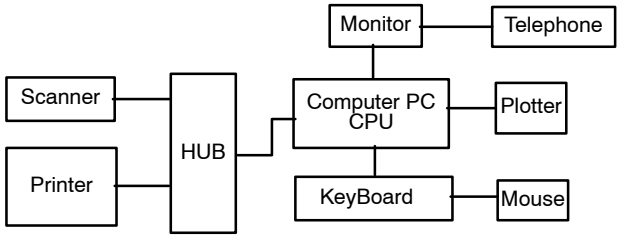


Figure 4. Typical USB System

Typically the USB system consists of one host, hubs and devices.

The Host

The host in the USB system, is responsible to the whole complexity of the protocol (simplifies the designing of USB devices). The host controls the media access, therefore, no one can access the bus unless it got an approval required from the host.

The Hub

The hub provides an interconnect point, which enables many devices to connect to a single USB port. The logical topology of the USB is a star structure, all the devices are connected (logically) directly to the host. It is totally transparent to the device what is its' hub tier (the number of hubs the data has to flow through). The hub is connected to the USB host in the upstream direction (data flows "up" to the host) and is connected to the USB device in the downstream direction (data flows "down" from the host to the device). The hubs' main functionality is the responsibility of detecting an attachment and detachment of devices, handling the power management for devices that are bus−powered (get power from the bus), and responsibility for bus error detection and recovery. Another important role of the hub is to manage both full and low speed devices. When a device is attached to the system the hub detects the speed, which the device operates in, and through the whole communication on the bus prevents from full speed traffic to reach low seed device and vice versa – prevent from low speed traffic to reach full speed device.

The Device

The Device is defined as everything in the USB system, which is not a host (including hubs). A device provides one or more USB functions. Most of the devices provide only one function but there may be some, which provides more than one and called compound devices. We refer to two kinds of devices − self powered or bus powered devices. A device that gets its power from the bus is called bus powered and on the other hand a device which supplies its own power is called self powered. There are two kinds of devices for USB 1.1:

Full−speed devices − operates in 12 Mb/s

Low−speed devices that work in 1.5 Mb/s.

NUF2221W1 Device Information

The Universal Serial Bus (USB) specification revision 1.1 requires the USB drivers to have certain impedance characteristics. The series resistance plus the USB driver output resistance must be close to the USB cable's impedance of 45 Ω unbalanced (90 Ω balance) to minimize transmission line reflections. In addition USB 1.1 also requires upstream ports to be terminated with a pull−up resistor (usually 1.5 kΩ) from D+ or D− lines to V_{CC}=3.3 V (V_{CC} is usually taken from V_{BUS} by using a 5 V − 3.3 V regulator). In case of EMI, the radiated and conducted EMI should be kept within the required levels as specified by the FCC regulations. Actual FCC regulations requires that class B computing devices meet the specifications of maximum levels for both radiated and conducted EMI (Radiated EMI covers the frequency range from 30 MHz to 1 GHz and Conducted EMI covers the 450 kHz to 30MHz range).

The NUF2221W1 device from On Semiconductor provides series termination, EMI filtering and ESD protection for the two data lines (D+, D−) as well as for the VBUS. The ESD device's ratings comply with IEC61000−4−2 (Level 4), HBM class 3B and MM class C. All these features are offered in an integrated solution placed

in a small and single package (SC−88, Case 419B). The NUF2221W1 device is shown in the Figure 5.

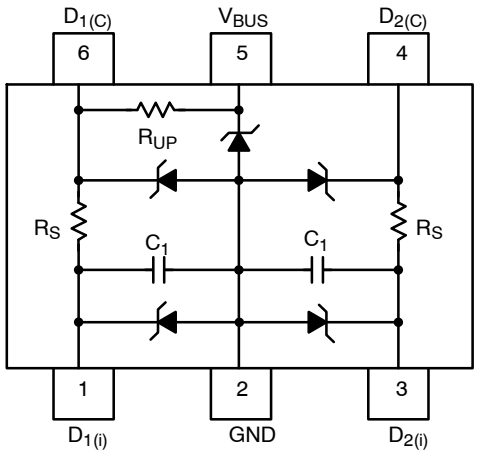


Figure 5. Device Description

Connection for Full− Speed and Low−Speed Devices

The USB 1.1 specification calls for two data rates:

- Full−speed devices − operates in 12 Mb/s
- Low−speed devices that work in 1.5 Mb/s.

The NUF2221W1 device can be shaped for either full−speed or low−speed by connecting one of the data lines (D+, D−) to a 3.3 V voltage supply through the 1.5 kΩ pull up resistor. The device's connection diagrams for each speed are described as follows:

Full−Speed Connection

The Pull up resistor (R_{UP}) is connected to the D+ Line. The terminal 5 is connected to a 3.3 V voltage supply while the terminal 2 is connected to ground. The input of the D+ line is connected in the terminal 1 which outputs from the terminal 6. Finally, the input of the D− line is connected in the terminal 3 which outputs from the terminal 4. Figure 6 shows the connections of the NUF2221W1 device for "Full−Speed".

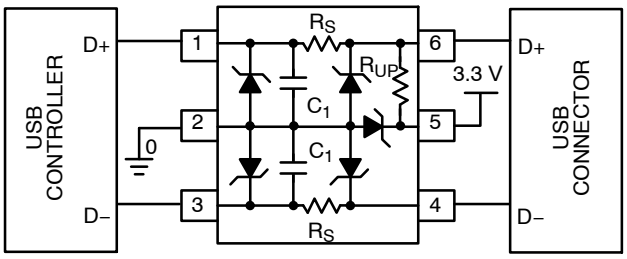


Figure 6. Full Speed Connection

Low−Speed Connection

The Pull up resistor (R_{UP}) is connected to the D− Line. The terminal 5 is connected to a 3.3 V voltage supply while the terminal 2 is connected to ground. The input of the D− line is connected in the terminal 1 which outputs from the terminal 6. Finally, the input of the D+ line is connected in the terminal 3 which outputs from the terminal 4. The Figure 7 shows the connections of the NUF2221W1 device for "Low−Speed".

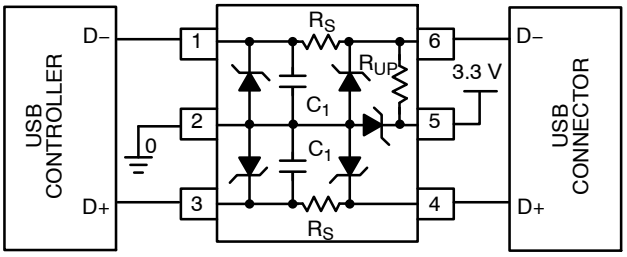
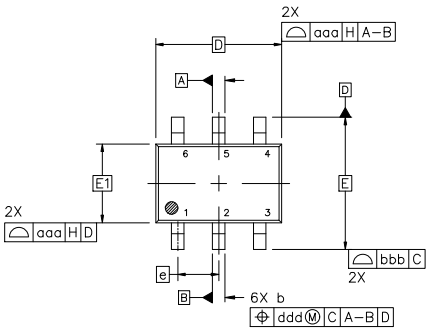


Figure 7. Low Speed Connection

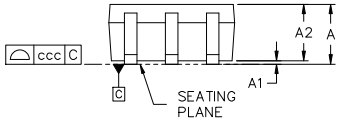


SC−88 2.00x1.25x0.90, 0.65P
CASE 419B−02
ISSUE Z

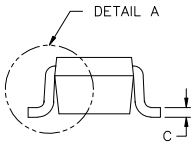
DATE 18 APR 2024



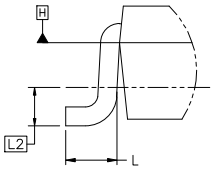
TOP VIEW



SIDE VIEW



END VIEW

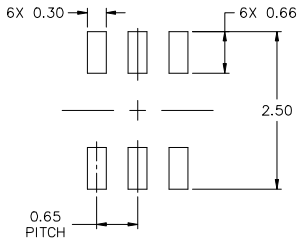


DETAIL A
SCALE 2:1

NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5−2018.
2. ALL DIMENSION ARE IN MILLIMETERS.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.20 PER END.
4. DIMENSIONS D AND E1 AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AND DATUM H.
5. DATUMS A AND B ARE DETERMINED AT DATUM H.
6. DIMENSIONS b AND c APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.08 AND 0.15 FROM THE TIP.
7. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 TOTAL IN EXCESS OF DIMENSION b AT MAXIMUM MATERIAL CONDITION. THE DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT.

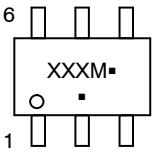
	MILLIMETERS		
DIM	MIN.	NOM.	MAX.
A	−−−	−−−	1.10
A1	0.00	−−−	0.10
A2	0.70	0.90	1.00
b	0.15	0.20	0.25
c	0.08	0.15	0.22
D	2.00 BSC		
E	2.10 BSC		
E1	1.25 BSC		
e	0.65 BSC		
L	0.26	0.36	0.46
L2	0.15 BSC		
aaa	0.15		
bbb	0.30		
ccc	0.10		
ddd	0.10		



RECOMMENDED MOUNTING FOOTPRINT*

* FOR ADDITIONAL INFORMATION ON OUR Pb−FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ONSEMI SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

GENERIC MARKING DIAGRAM*



XXX = Specific Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or position may vary depending upon manufacturing location.

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

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DESCRIPTION:	**SC−88 2.00x1.25x0.90, 0.65P**		**PAGE 1 OF 2**

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SC−88 2.00x1.25x0.90, 0.65P
CASE 419B−02
ISSUE Z

DATE 18 APR 2024

STYLE 1:
PIN 1. EMITTER 2
2. BASE 2
3. COLLECTOR 1
4. EMITTER 1
5. BASE 1
6. COLLECTOR 2

STYLE 2:
CANCELLED

STYLE 3:
CANCELLED

STYLE 4:
PIN 1. CATHODE
2. CATHODE
3. COLLECTOR
4. EMITTER
5. BASE
6. ANODE

STYLE 5:
PIN 1. ANODE
2. ANODE
3. COLLECTOR
4. EMITTER
5. BASE
6. CATHODE

STYLE 6:
PIN 1. ANODE 2
2. N/C
3. CATHODE 1
4. ANODE 1
5. N/C
6. CATHODE 2

STYLE 7:
PIN 1. SOURCE 2
2. DRAIN 2
3. GATE 1
4. SOURCE 1
5. DRAIN 1
6. GATE 2

STYLE 8:
CANCELLED

STYLE 9:
PIN 1. EMITTER 2
2. EMITTER 1
3. COLLECTOR 1
4. BASE 1
5. BASE 2
6. COLLECTOR 2

STYLE 10:
PIN 1. SOURCE 2
2. SOURCE 1
3. GATE 1
4. DRAIN 1
5. DRAIN 2
6. GATE 2

STYLE 11:
PIN 1. CATHODE 2
2. CATHODE 2
3. ANODE 1
4. CATHODE 1
5. CATHODE 1
6. ANODE 2

STYLE 12:
PIN 1. ANODE 2
2. ANODE 2
3. CATHODE 1
4. ANODE 1
5. ANODE 1
6. CATHODE 2

STYLE 13:
PIN 1. ANODE
2. N/C
3. COLLECTOR
4. EMITTER
5. BASE
6. CATHODE

STYLE 14:
PIN 1. VREF
2. GND
3. GND
4. IOUT
5. VEN
6. VCC

STYLE 15:
PIN 1. ANODE 1
2. ANODE 2
3. ANODE 3
4. CATHODE 3
5. CATHODE 2
6. CATHODE 1

STYLE 16:
PIN 1. BASE 1
2. EMITTER 2
3. COLLECTOR 2
4. BASE 2
5. EMITTER 1
6. COLLECTOR 1

STYLE 17:
PIN 1. BASE 1
2. EMITTER 1
3. COLLECTOR 2
4. BASE 2
5. EMITTER 2
6. COLLECTOR 1

STYLE 18:
PIN 1. VIN1
2. VCC
3. VOUT2
4. VIN2
5. GND
6. VOUT1

STYLE 19:
PIN 1. I OUT
2. GND
3. GND
4. V CC
5. V EN
6. V REF

STYLE 20:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. EMITTER
5. COLLECTOR
6. COLLECTOR

STYLE 21:
PIN 1. ANODE 1
2. N/C
3. ANODE 2
4. CATHODE 2
5. N/C
6. CATHODE 1

STYLE 22:
PIN 1. D1 (i)
2. GND
3. D2 (i)
4. D2 (c)
5. VBUS
6. D1 (c)

STYLE 23:
PIN 1. Vn
2. CH1
3. Vp
4. N/C
5. CH2
6. N/C

STYLE 24:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE

STYLE 25:
PIN 1. BASE 1
2. CATHODE
3. COLLECTOR 2
4. BASE 2
5. EMITTER
6. COLLECTOR 1

STYLE 26:
PIN 1. SOURCE 1
2. GATE 1
3. DRAIN 2
4. SOURCE 2
5. GATE 2
6. DRAIN 1

STYLE 27:
PIN 1. BASE 2
2. BASE 1
3. COLLECTOR 1
4. EMITTER 1
5. EMITTER 2
6. COLLECTOR 2

STYLE 28:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. SOURCE
5. DRAIN
6. DRAIN

STYLE 29:
PIN 1. ANODE
2. ANODE
3. COLLECTOR
4. EMITTER
5. BASE/ANODE
6. CATHODE

STYLE 30:
PIN 1. SOURCE 1
2. DRAIN 2
3. DRAIN 2
4. SOURCE 2
5. GATE 1
6. DRAIN 1

Note: Please refer to datasheet for style callout. If style type is not called out in the datasheet refer to the device datasheet pinout or pin assignment.

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