

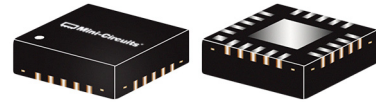
# Surface Mount Digital Step Attenuator

## DAT-31575A Series

75Ω 0 to 31.5 dB, 0.5 dB Step 1MHz to 2.5 GHz

### The Big Deal

- Wideband, operates up to 2.5 GHz
- Glitchless attenuation transitions
- High IP3, 52 dBm



CASE STYLE: DG983-2

### Product Overview

The DAT-31575A+ series of 75Ω digital step attenuators provides adjustable attenuation from 0 to 31.5 dB in 0.5 dB steps. The control is a 6-bit serial/parallel interface, and the attenuators operate with either single positive or dual (positive and negative) supply voltage. DAT-31575A+ series models are produced by a unique CMOS process on silicon, offering the performance of GaAs with the advantages of conventional CMOS devices.

### Key Features

Feature	Advantages
Wideband operation, specified from 1MHz to 2.5 GHz	Can be used in multiple applications such as various versions of DOCSIS, satellite and defense, reducing part count.
Serial or parallel interface	Models available with serial or parallel interface mode to suit customer demand.
Good VSWR, 1.3:1 typ.	Eases interfacing with adjacent components and results in low amplitude ripple.
Single positive supply models: (Model suffixes: -SP+ and -PP+) +2.3 to +3.6V+	Use of single positive supply simplifies power supply design. An internal negative voltage generator supplies the desired negative voltage. Single positive supply results in excellent spurious performance, -140 dBm typical.
Dual supply models: (Model suffixes: -SN+ and -PN+) +2.7 to +3.6V (Positive) and -3.6 to -3.2V (Negative)	Dual supply provides spurious-free operation. It also allows fast switching up to 1 MHz (vs. 25 kHz for single supply).
Useable over a wide range of supply voltages, +2.3/2.7 to 5.2V	Wide range of positive operating voltages allows the DAT-31575A+ Series of models to be used in a wide range of applications. See Application Note AN-70-032 for operation above +3.6V
Footprint compatible to DAT-31575-XX+ Series (XX=SN/SP/PN/PP)	Can fit into existing footprint and provide wideband performance, to 2.5 GHz instead of 2.0 GHz.
Glitchless Attenuation Transitions, 0.26 typical	Compared to previous generation of digital attenuators which is a vast improvement.



# Digital Step Attenuator

75Ω 1-2500 MHz

31.5 dB, 0.5 dB Step

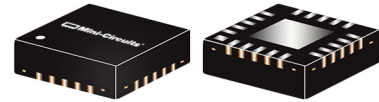
6 Bit, Serial Control Interface, Single Supply Voltage

## Product Features

- Single positive supply voltage
- Immune to latch up
- Glitchless attenuation transitions
- Excellent accuracy, 0.1 dB Typ
- Low Insertion Loss
- High IP3, +55-59 dBm Typ
- Very low DC power consumption
- Excellent return loss, 18 dB Typ
- Small size 4.0 x 4.0 mm

## Typical Applications

- DOCSIS® 3.1
- Portable Wireless
- CATV & DBS
- MMDS & Wireless LAN
- Wireless Local Loop
- UNII & Hiper LAN
- Power amplifier distortion canceling loops



## DAT-31575A-SP+

CASE STYLE: DG983-2

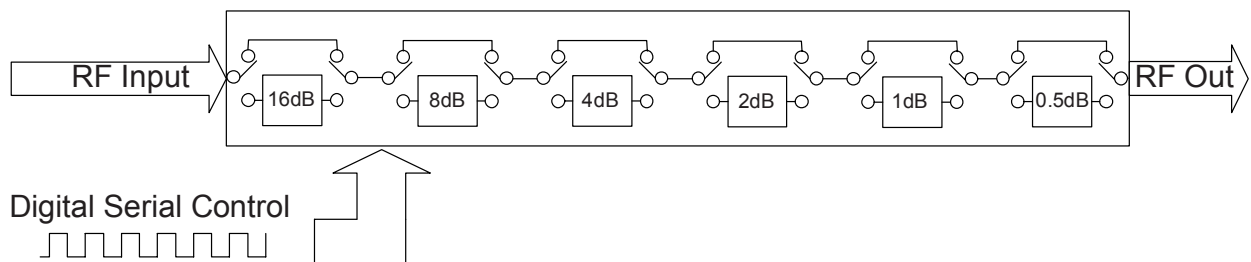
**+RoHS Compliant**

*The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications*

## General Description

The DAT-31575A-SP+ is a 75Ω RF digital step attenuator that offers an attenuation range up to 31.5 dB in 0.5 dB steps. The control is a 6-bit Serial interface, operating on single (positive) supply voltage. The DAT-31575A-SP+ is produced using a unique CMOS process on silicon, offering the performance of GaAs, with the advantages of conventional CMOS devices.

## Simplified Schematic



## RF Electrical Specifications, 1-2500 MHz, T<sub>AMB</sub>=25°C, V<sub>DD</sub>=+3V, 75Ω

Parameter	Freq. Range (GHz)	Min.	Typ.	Max.	Units
Accuracy @ 0.5 dB Attenuation Setting	0.001-1.2	—	0.03	0.17	dB
	1.2-2.0	—	0.05	0.18	
	2.0-2.5	—	0.1	0.19	
Accuracy @ 1 dB Attenuation Setting	0.001-1.2	—	0.03	0.18	dB
	1.2-2.0	—	0.1	0.20	
	2.0-2.5	—	0.1	0.23	
Accuracy @ 2 dB Attenuation Setting	0.001-1.2	—	0.07	0.21	dB
	1.2-2.0	—	0.15	0.26	
	2.0-2.5	—	0.15	0.31	
Accuracy @ 4 dB Attenuation Setting	0.001-1.2	—	0.05	0.27	dB
	1.2-2.0	—	0.15	0.36	
	2.0-2.5	—	0.2	0.47	
Accuracy @ 8 dB Attenuation Setting	0.001-1.2	—	0.1	0.39	dB
	1.2-2.0	—	0.24	0.60	
	2.0-2.5	—	0.35	0.79	
Accuracy @ 16 dB Attenuation Setting	0.001-1.2	—	0.23	0.63	dB
	1.2-2.5	—	0.8	1.0	
	2.0-2.5	—	0.8	1.43	
Insertion Loss <sup>1</sup> @ all attenuator set to 0dB	0.001-1.2	—	1.2	1.8	dB
	1.2-2.5	—	1.6	1.9	
VSWR	0.001-1.2	—	1.3	—	:1
	1.2-2.5	—	1.4	—	
Input IP3 (at Min. and Max. Attenuation)	.005-2.5	—	55-69	—	dBm
Input IP2	.005-2.5	—	See Fig. 1	—	dBm
Input Power @ 0.1dB Compression (at Min. and Max. Attenuation)	0.030-2.5	—	+30	—	dBm
Input Operating Power	1 MHz to 30 MHz	—	—	See Fig. 2	dBm
	>30 MHz	—	—	+24	
Thermal Resistance (Junction to case)	—	—	25	—	°C/W

## DC Electrical Specifications

Parameter	Min.	Typ.	Max.	Units
V <sub>DD</sub> Supply Voltage	2.3	3	3.6 <sup>2</sup>	V
I <sub>DD</sub> Supply Current	—	—	200	μA
Control Input Low	-0.3	—	0.6 <sup>3</sup>	V
Control Input High	1.17	—	3.6	V
Control Current	—	—	20	μA

1. Loss values are de-embedded from test board Loss (test board's Insertion Loss: 0.10dB @ 100MHz, 0.40dB @ 1200MHz, 0.55dB @ 2000MHz, 0.75dB @ 4000MHz).
2. For operation above +3.6V see application note, AN-70-032
3. 0 Volt during power up.

## Absolute Maximum Ratings<sup>4</sup>

Parameter	Ratings
Operating Temperature	-40°C to 105°C
Storage Temperature	-65°C to 150°C
V <sub>DD</sub>	-0.3V Min., 5.5V Max.
Voltage on any input	-0.3V Min., 3.6V Max.
Input Power	1-30 MHz
	30-2500 MHz
	Figure 1
	+30dBm

4. Permanent damage may occur if any of these limits are exceeded.
5. Operation between max operating and absolute max input power will result in reduced reliability.

## Switching Specifications

Parameter	Min.	Typ.	Max.	Units
Switching Speed, 50% Control to 90% or 10% of RF	—	0.4	0.7	μSec
Switching Control Frequency	—	—	25	kHz

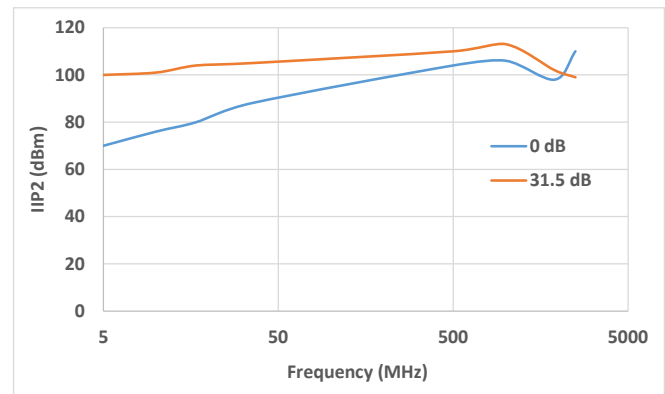


Figure 1. IP2 vs. frequency and attenuation

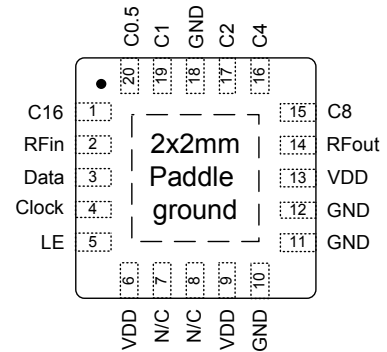
## Pin Description

Function	Pin Number	Description
C16	1	Control for Attenuation bit, 16dB (Note 3, 7)
RF in	2	RF in port (Note 1)
Data	3	Serial Interface data input (Note 4)
Clock	4	Serial Interface Clock input
LE	5	Latch Enable Input (Note 2)
V <sub>DD</sub>	6	Positive Supply Voltage
N/C	7	Not connected (Note 7)
N/C	8	Not connected
V <sub>DD</sub>	9	Positive Supply Voltage
GND	10	Ground connection
GND	11	Ground connection
GND	12	Ground connection (Note 6)
V <sub>DD</sub>	13	Positive Supply Voltage
RF out	14	RF out port (Note 1)
C8	15	Control for attenuation bit, 8 dB
C4	16	Control for attenuation bit, 4 dB
C2	17	Control for attenuation bit, 2 dB
GND	18	Ground Connection
C1	19	Control for attenuation bit, 1 dB
C0.5	20	Control for Attenuation bit, 0.5 dB (Note 7)
GND	Paddle	Paddle ground (Note 5)

### Notes:

- Both RF ports must be held at 0VDC or DC blocked with an external series capacitor.
- Latch Enable (LE) has an internal 2MΩ to internal positive supply voltage.
- Place a 10KΩ resistor in series to be compatible with previous generation of models. and 10KΩ maybe omitted in new designs.
- Place a shunt 10KΩ resistor to GND
- The exposed solder pad on the bottom of the package (See Pin configuration) must be grounded for proper device operation.
- Ground must be less than 80 mil (0.08") from Pin 12 for proper device operation.
- This pin has an internal 1MΩ resistor to ground.

## Pin Configuration (Top View)



## Device Marking

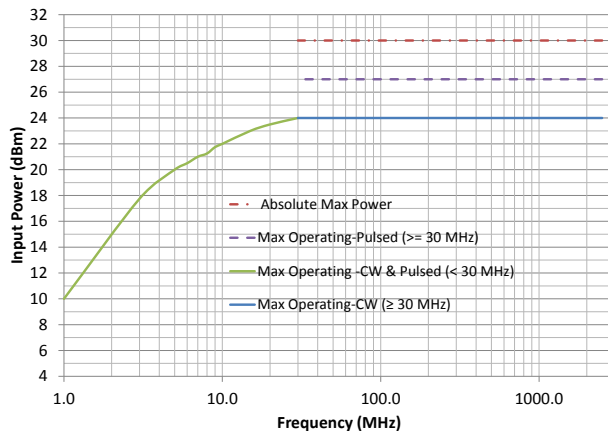
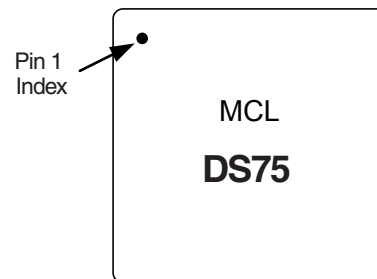
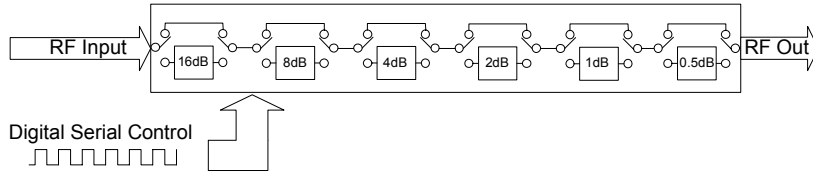


Figure 2. Max Input power vs. frequency.  
Pulsed Power: 5% duty cycle, 4620 μS period

## Simplified Schematic



The DAT-31575A-SP+ Serial interface consists of 6 control bits that select the desired attenuation state, as shown in **Table 1: Truth Table**

Table 1. Truth Table						
Attenuation State	C16	C8	C4	C2	C1	C0.5
Reference	0	0	0	0	0	0
0.5 (dB)	0	0	0	0	0	1
1 (dB)	0	0	0	0	1	0
2 (dB)	0	0	0	1	0	0
4 (dB)	0	0	1	0	0	0
8 (dB)	0	1	0	0	0	0
16 (dB)	1	0	0	0	0	0
31.5 (dB)	1	1	1	1	1	1

Note: Not all 64 possible combinations of C0.5 - C16 are shown in table

The serial interface is a 6-bit serial in, parallel-out shift register buffered by a transparent latch.

It is controlled by three CMOS-compatible signals: Data, Clock, and Latch Enable (LE). The Data and Clock inputs allow data to be serially entered into the shift register, a process that is independent of the state of the LE input.

The LE input controls the latch. When LE is HIGH, the latch is transparent and the contents of the serial shift register control the attenuator. When LE is brought LOW, data in the shift register is latched.

The shift register should be loaded while LE is held LOW to prevent the attenuator value from changing as data is entered. The LE input should then be toggled HIGH and brought LOW again, latching the new data. The timing for this operation is defined by **Figure 3** (Serial Interface Timing Diagram) and **Table 2** (Serial Interface AC Characteristics).

**Figure 3: Serial Interface Timing Diagram**

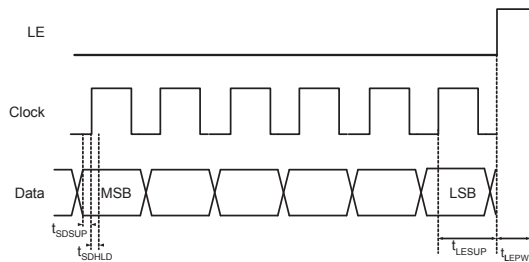


Table 2. Serial Interface AC Characteristics				
Symbol	Parameter	Min.	Max.	Units
$f_{clk}$	Serial data clock frequency (Note 1)		10	MHz
$t_{clkH}$	Serial clock HIGH time	30		ns
$t_{clkL}$	Serial clock LOW time	30		ns
$t_{LESUP}$	LE set-up time after last clock falling edge	10		ns
$t_{LEPW}$	LE minimum pulse width	30		ns
$t_{SDSUP}$	Serial data set-up time before clock rising edge	10		ns
$t_{SDHLD}$	Serial data hold time after clock falling edge	10		ns

Note 1. fclk verified during the functional pattern test. Serial programming sections of the functional pattern are clocked at 10MHz to verify fclk specification.

The DAT-31575A-SP+, uses a common 6-bit serial word format, as shown in **Table 3**: 6-Bit attenuator Serial Programming Register Map.

The first bit, the MSB, corresponds to the 16-dB Step and the last bit, the LSB, corresponds to the 0.5 dB step.

B5	B4	B3	B2	B1	B0
C16	C8	C4	C2	C1	C0.5

↑

MSB  
(first in)

↑

LSB  
(last in)

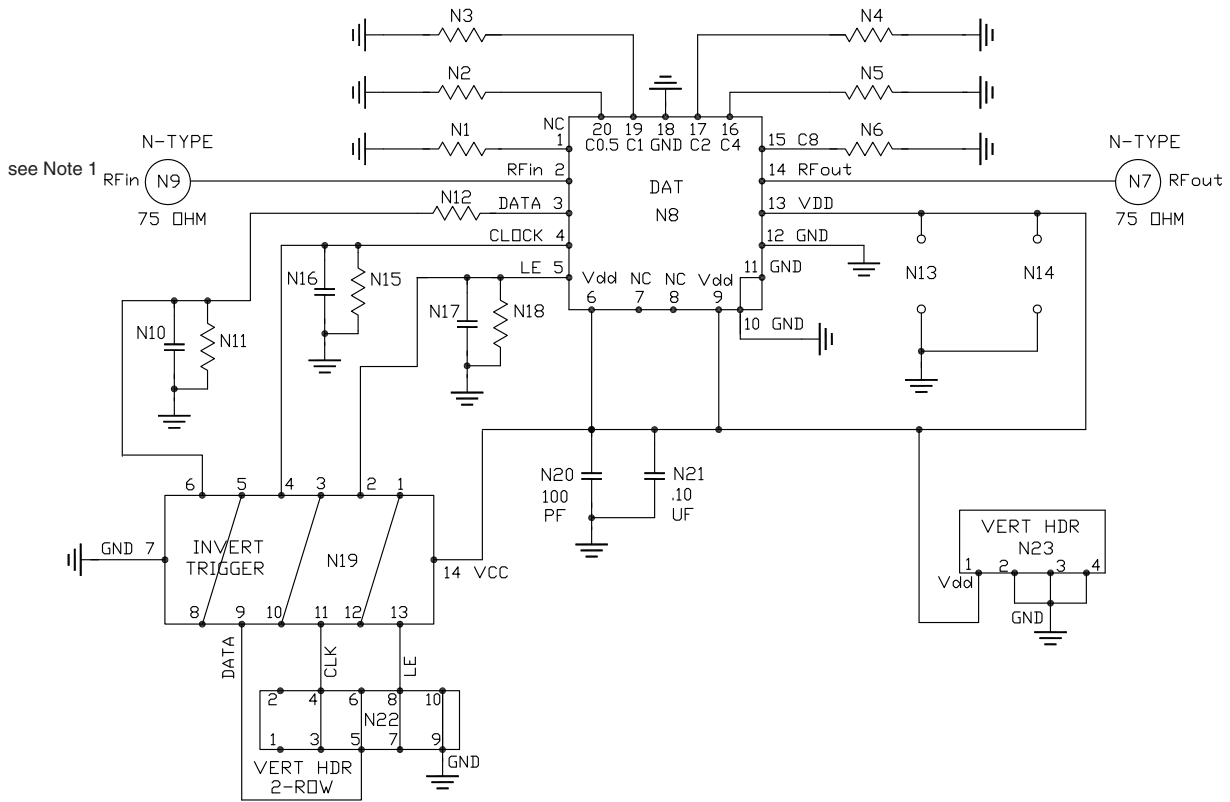
### Power-up Control Settings

The DAT-31575A-SP+ always assumes a specifiable attenuation setting on power-up, allowing a known attenuation state to be established before an initial serial control word is provided.

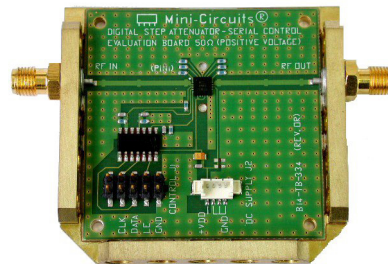
When the attenuator powers up, the five control bits are set to whatever data is present on the six data inputs (C0.5 to C16).

This allows any one of the 64 attenuation settings to be specified as the power-up state.

## TB-344 Evaluation Board Schematic Diagram



Note 1: Both RF ports must be held at 0VDC or DC blocked with an external series capacitor.



**TB-344**

Bill of Materials	
N1-N6, N11, N12, N15, N18	Resistor 0603 10 KOhm +/- 1%
N10, N16, N17, N20	NPO Capacitor 0603 100pF +/- 5%
N21	Tantalum Capacitor 0805 100nF +/- 10%
N19	Hex Invert Schmitt Trigger MSL1

\*\*N12 can be reduced to 0 Ohms

Additional Detailed Technical Information	
<i>additional information is available on our dash board. To access this information <a href="#">click here</a></i>	
<b>Performance Data</b>	Data Table
	Swept Graphs
	S-Parameter (S2P Files) Data Set (.zip file)
<b>Case Style</b>	DG983-2 <i>Plastic package, exposed paddle, lead finish: NiPdAu</i>
<b>Tape &amp; Reel</b> Standard quantities available on reel	F87 <i>7" reels with 20, 50, 100 or 200 devices</i> <i>13" reels with 3K devices</i>
<b>Suggested Layout for PCB Design</b>	PL-203
<b>Evaluation Board</b>	TB-344
<b>Environmental Ratings</b>	ENV33T1

## ESD Rating

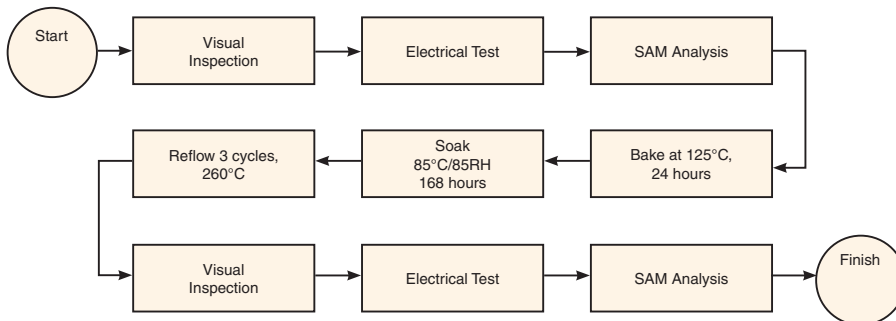
Human Body Model (HBM): Class 1C (1000 to <2000V) in accordance with MIL-STD-883 method 3015 (pass 1500V).

Charge Device Model (CDM): Class C3 (>1000V) per JESD22-C101F

## MSL Rating

Moisture Sensitivity: MSL1 in accordance with IPC/JEDEC J-STD-020D

## MSL Test Flow Chart



## Additional Notes

- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuits' applicable established test performance criteria and measurement instructions.
- C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at [www.minicircuits.com/MCLStore/terms.jsp](http://www.minicircuits.com/MCLStore/terms.jsp)