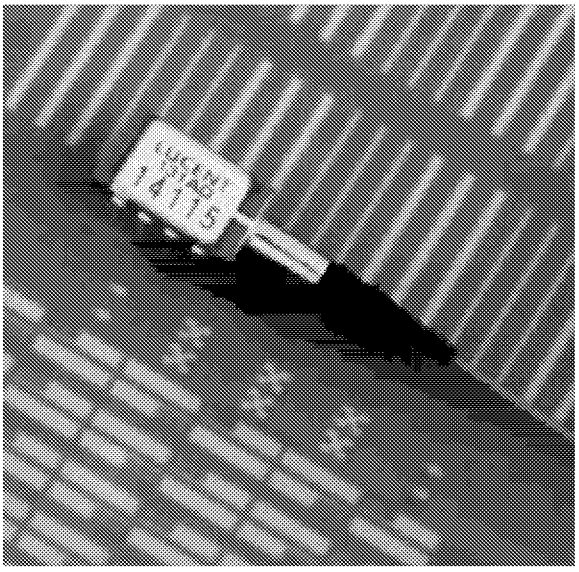
Data Sheet
April 1998

microelectronics group

Lucent Technologies
Bell Labs Innovations

131-Type Long-Wavelength PIN Photodetector



The 131-Type PIN low-profile photodetector offers excellent coupling stability based on Lucent Technologies Microelectronics Group's patented Advanced Lightwave Platform technology.

Features

- Wavelength: 1.1 μm—1.6 μm
- Planar structure for high reliability
- Low-profile, 8-lead DIP or 3-lead, coaxial package equivalent pinout
- Wide operating temperature range: –40 °C to +85 °C
- High optical coupling stability
- Wide selection of fiber pigtails and connectors available
- High performance
  - — High responsivity
  - — Very low dark current
  - — High optical input saturation level
  - — High speed for digital applications
  - — High linearity and low back reflections for analog applications

Applications

Digital

- Telecommunications
  - — Fiber-in-the-loop (FITL) narrowband application
  - — SONET/SDH transmission systems
  - — Digital cellular
- Datacom
  - — Local area networks
  - — 1 Gbits/s fibre channel
- Military
  - — Microwave systems
  - — Remote antennae
  - — Tactical communications

Analog

- Analog systems
  - — CATV trunk and loop
  - — Micro-/picocellular
  - — Microwave
- Telecommunications
  - — Fiber in the loop (FITL)
  - — Broadband
- Military
  - — Microwave systems
  - — Remote antennae
  - — Tactical communications

Description

The 131-Type photodetectors represent a family of low-profile, high-reliability pigtailed devices specially engineered for the rigorous demands of either analog applications or digital fiber-optic applications. These photodetectors are based upon Lucent Technologies' patented Advanced Lightwave Platform technology, permitting high optical coupling stability and unparalleled performance.

Low-profile package choices are an 8-lead DIP or a 3-lead out-the-back style, thus allowing pinout-equivalent replacements for lower-performance coaxial-type packages. Their low profile makes them ideal for close board-to-board spacing situations.

The 131-Type PIN Photodetectors contain a rear-illuminated planar diode structure. Lucent Technologies employs unique diode processing steps to achieve a low capacitance and highly linear active area that ensures a wide dynamic operating range. Responsivity is typically >0.85 A/W with rise and fall times of <0.5 ns at the 1.3 μm wavelength.

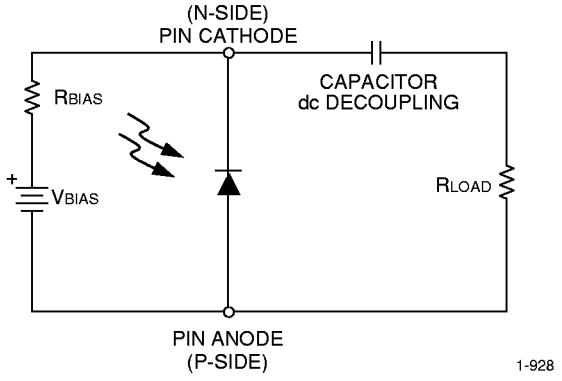
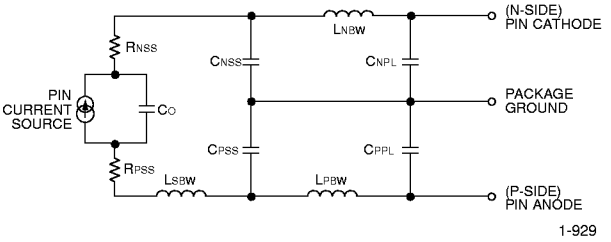


Figure 1. Typical Bias Connection

This PIN's construction involves a patented silicon optical bench that supplies mechanical stability to the fiber and directive channeling of input light. The structure also allows it to handle strong levels of input power. All fiber types are specially terminated inside the package to minimize back reflections.

These PIN photodetectors perform effectively and efficiently over the entire 1.1 μm to 1.6 μm long wavelength range. They have been employed in a number of diverse applications including digital cellular, remote monitoring, high-speed datacom, fiber-to-the-curb, and CATV signaling.



Notes:

This equivalent circuit is intended as an aid for modeling the device/package parasitics in order for the circuit designer to better match impedance and optimize bandwidth performance.

Minimum parasitic effects can be achieved by connecting the PIN cathode (N-side) to circuit ground, applying a negative voltage to the PIN anode (P-side), and allowing the package voltage to float by **not** connecting the package ground to circuit ground.

Typical values are as follows:
C_O = Bulk capacitance of the diode = 0.3 pF to 0.5 pF.
R_{NSS}, R_{PSS} = Bulk resistance of the contacts = 5 Ω.
L_{SBW} = Series inductance of P-side bond wire = 0.25 nH.
C_{NSS}, C_{PSS} = Substrate capacitance = 0.975 pF/0.28 pF, respectively.
L_{NBW}, L_{PBW} = Series inductance of the substrate to package lead bond wire = 2.0 nH.
C_{NPL}, C_{PPL} = Package lead capacitance = 0.40 pF/0.46 pF, respectively.

Figure 2. Equivalent ac Circuit for Analog Applications

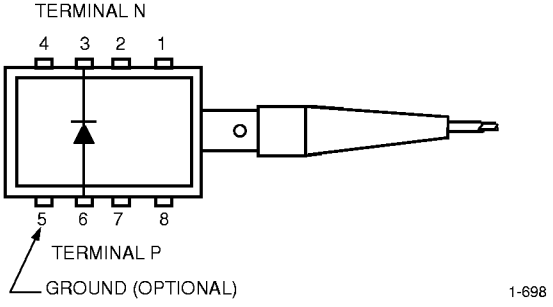


Figure 3. 8-Lead DIP Electrical Connections

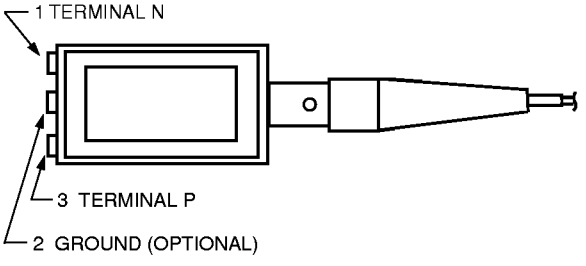


Figure 4. 3-Lead Electrical Connections

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Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Operating Temperature Range	T_A	–40	85	°C
Storage Temperature Range	T_{stg}	–40	90	°C
Forward Voltage	V_F	—	0	V
Reverse Voltage*	V_R	—	30	V
Photocurrent	—	—	4	mA
Humidity	—	—	95	%
ESD Threshold	—	—	>250	V

* The recommended reverse bias voltage is 5 V to 15 V.

Handling Precautions

Electrostatic Discharge

CAUTION: This device is susceptible to damage as a result of electrostatic discharge. Take proper precautions during both handling and testing. Follow guidelines such as JEDEC Publication No. 108-A (Dec. 1988).

Although protection circuitry is designed into the device, take proper precautions to avoid exposure to ESD.

Lucent Technologies employs a human-body model (HBM) for ESD-susceptibility testing and protection-design evaluation. ESD voltage thresholds are dependent on the critical parameters used to define the model. A standard HBM (resistance = 1.5 kΩ, capacitance = 100 pF) is widely used and, therefore, can be used for comparison purposes. The HBM ESD threshold presented here was obtained by using the following circuit parameters:

Parameter	Value	Unit
HBM Threshold	250	V

Electrical Characteristics

Minimum and maximum values are testing requirements. Typical values are for informational purposes only and are not part of the testing requirements. Each device is provided with recommended operating conditions to achieve specified performance. T_C = 25 °C, unless noted otherwise. Determinations made using a 50 Ω load.

Parameter	Symbol	Min	Typ	Max	Unit
Capacitance (f < 900 MHz):					
131 8-Lead DIP*	—	—	0.7	—	pF
131 3-Lead SIP*	—	—	0.9	—	pF
Rise/Fall Time	t_R/t_F	—	<0.5	—	ns
Dark Current	I_D	—	1.0	5	nA
Reverse Voltage	V_R	2	15	30	V

* The minimum capacitance configuration occurs when the N-side of the PIN is grounded and a negative voltage is applied to the P-side, with the package floating, not grounded (value reference only; not tested in manufacture).

Optical Characteristics

Tc = 25 °C.

Parameter	Symbol	Min	Typ	Max	Unit
Responsivity:					
Type 1	R	0.75	0.85	—	A/W
Type 2	R	0.85	0.92	—	A/W
Type 3	R	0.90	0.95	—	A/W
Optical Back Reflection*:					
Type 1	—	—	–35	–20	dB
Type 2	—	—	–60	–40	dB
Wavelength Range	—	1.1	—	1.6	μm
Linearity:					
Type L1:					
Second Order†	—	—	–52	–48	dBc
Third Order‡	—	—	–65	–60	dBc
Type L2:					
Second Order	—	—	–68	–63	dBc
Third Order	—	—	–70	–65	dBc
Type L3:					
Second Order	—	—	–75	–70	dBc
Third Order	—	—	–75	–70	dBc
Type L4:					
Second Order	—	—	–80	–75	dBc
Third Order	—	—	—	–80	dBc
Type L5:					
Second Order	—	—	–85	–80	dBc
Third Order	—	—	–85	–80	dBc

* Does not include rotary mechanical splice loss (index matching is recommended).

† Second-order linearity measured at 15 V bias. The two tones are chosen to lie in the interval f_1 > 50 MHz, f_2 < 200 MHz; or such that $f_1 + f_2$ = 860 MHz and $f_1 - f_2$ = 50 MHz. See Figure 8 for typical bias response.

‡ Third-order linearity measured at 8 V bias. The two tones chosen are f_1 = 135.0 MHz and f_2 = 189.25 MHz. See Figure 9 for typical bias response.

Characteristic Curves

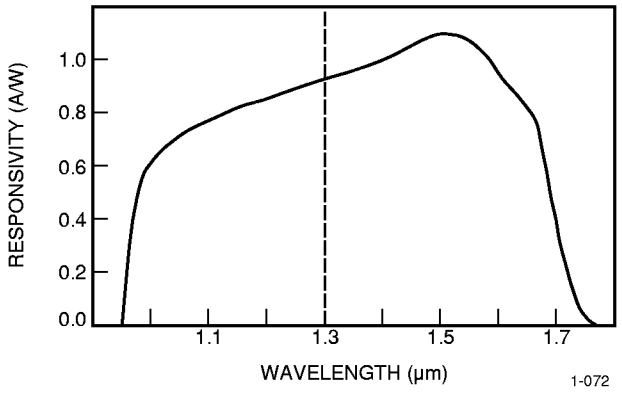


Figure 5. Responsivity as a Function of Wavelength

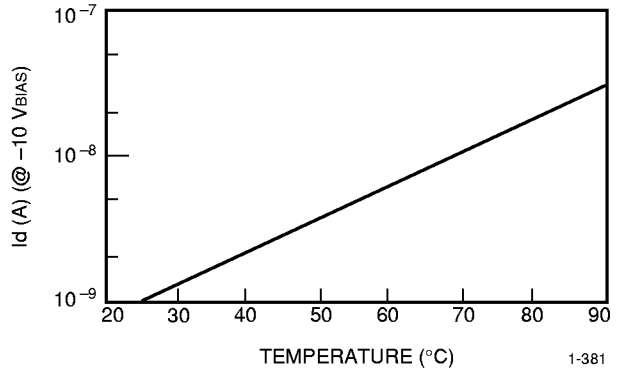


Figure 6. Typical Temperature Dependence of Dark Current

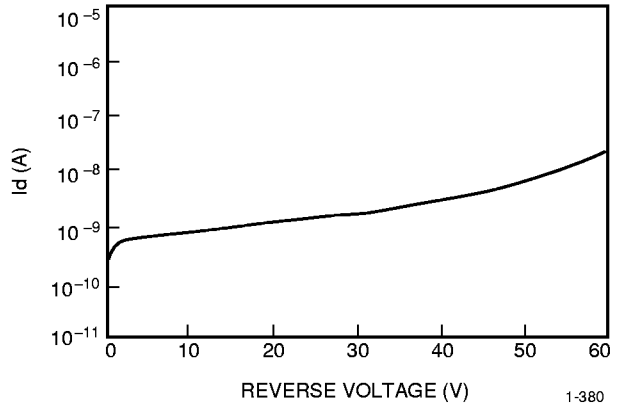


Figure 7. Reverse I-V at 23 °C

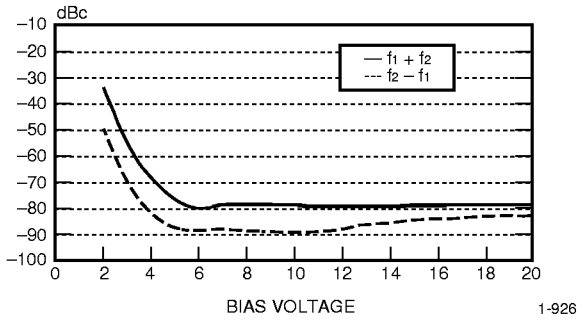


Figure 8. Second-Order Linearity, 1310 nm Wavelength; 0 dBm Optical Received Power; Two Tones @ 35% OMD per Tone

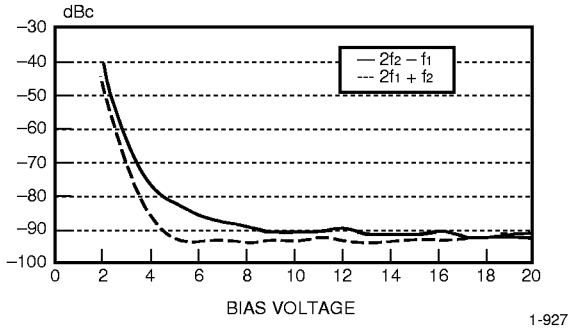


Figure 9. Third-Order Linearity, 1310 nm Wavelength; 0 dBm Optical Received Power; Two Tones @ 35% OMD per Tone

Reliability

Table 1. Test Qualifications

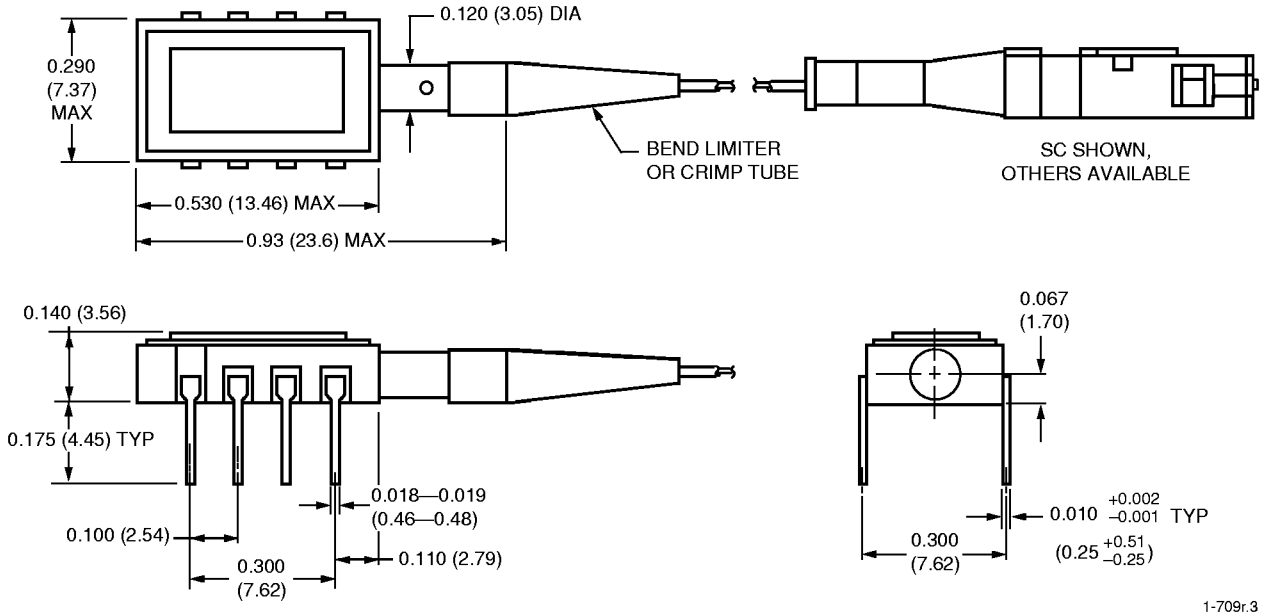
The 131-Type PIN Photodetectors have successfully passed the following qualifications and meet current Bellcore requirement TA-TSY-000468.

Test	Conditions	Sample Size	Failure Criteria
Physical Dimensions	MIL-STD-883C-2016	100	Visual
External Visual	MIL-STD-883C-2009.8	100	Visual
Mechanical Shock	MIL-STD-883C-2002.3 Condition B	11	Electrical/Optical
Variable Frequency Vibration	MIL-STD-883C-2007.2 Condition A	11	Electrical/Optical
Solderability	MIL-STD-883C-2003.6	11 (188 leads)	Visual
Solvent Resistance	MIL-STD-883C-2015.8	11	Visual
Temperature Cycling	MIL-STD-883C-1010.7 –40 °C to +85 °C	11	Electrical/Optical
High-temperature Operating Bias (HTOB)	MIL-STD-883C-1005.7 85 °C, 2,000 hrs., –5 Vdc	25	Electrical/Optical
Temperature Humidity Bias	MIL-STD-883C 85 °C, 85% RH, –5 Vdc, 500 cycles	11	Electrical/Optical
Thermal Shock	MIL-STD-883C-1011.9 –15 °C to +85 °C, 15 cycles	11	Electrical/Visual/ Optical
Moisture Resistance	MIL-STD-883C-1004.7 RT, 90% RH at 65 °C, 3 hrs., RT	11	Electrical/Visual/ Optical
Low-temperature Storage	–70 °C for 2,000 hrs.	11	Electrical/Optical
Fiber Pull	≥1 kg, 3 times	11	Electrical/Optical
Electrostatic Discharge	Human-body Model Class 1, 250 V max	—	—

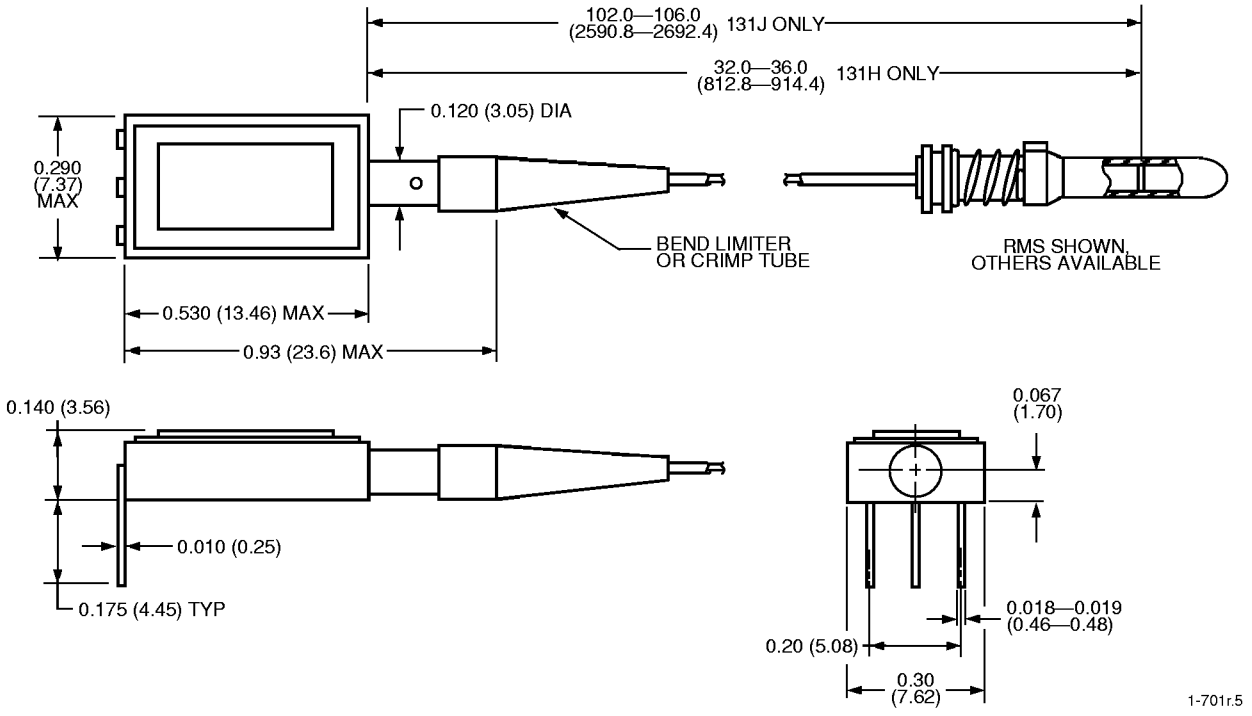
Outline Diagrams

Dimensions are in inches and (millimeters).

8-Lead DIP PIN Photodetectors



3-Lead PIN Photodetector



Note: For mechanical holding, an optional restraining clip (not shown) is supplied with all 131-lead photodetectors at no additional charge.

Ordering Information

Price Type	Code	Comcode	Package	Analog/ Digital	Responsivity Type	Linearity	Back Reflection Type	Fiber*	Connector
N	131A	106277478	8-lead	Digital	Type 1	NA	Type 1	SM	RMS
N	131B	106277486	8-lead	Digital	Type 1	NA	Type 1	MM	RMS
D	131D	106277502	8-lead	Analog	Type 2	L4	Type 2	SM	RMS
D	131E	106557473	8-lead	Analog	Type 2	L3	Type 2	SM	none
G	131G	106434277	8-lead	Analog	Type 1	L2	Type 2	SM	RMS
D	131H	106434335	3-lead	Analog	Type 2	L4	Type 2	SM	ST®
D	131J	106864101	3-lead	Analog	Type 2	L4	Type 2	SM	ST
N	131K	106864119	3-lead	Digital	Type 1	NA	Type 2	SM	RMS
K	131K	106864119	3-lead	Analog	Type 1	L1	Type 2	SM	RMS
L	131L	106864127	8-lead	Analog	Type 3	L5	Type 2	SM	RMS
N	131N	106864135	8-lead	Digital	Type 1	NA	Type 2	SM	RMS
K	131N	106864135	8-lead	Analog	Type 1	L1	Type 2	SM	RMS
G	131P	106912082	8-lead	Analog	Type 1	L2	Type 2	SM	FC-APC
D	131R	106953847	8-lead	Analog	Type 2	L4	Type 2	SM	FC-PC
D	131S	106953854	8-lead	Analog	Type 2	L4	Type 2	SM	FC-APC
G	131T	106953862	8-lead	Analog	Type 1	L2	Type 2	SM	FC-PC
G	131U	107080020	8-lead	Analog	Type 1	L2	Type 2	SM	HPC-108
AA	131AA	107230047	8-lead	Analog	Type 2	L4	Type 2	SM	FC-SPC
L	131AC	107875007	8-lead	Analog	Type 3	L5	Type 2	SM	SC-SPC
AA	131AD	107232845	8-lead	Analog	Type 2	L4	Type 2	SM	SC-SPC
N	131AE	107232852	8-lead	Digital	Type 1	NA	Type 2	SM	SC-SPC
N	131AF	107232860	8-lead	Digital	Type 1	NA	Type 2	SM	FC-SPC
AA	131AG	107577827	8-lead	Analog	Type 1	L3	Type 2	SM	SC-APC
AA	131AH	107689689	8-lead	Analog	Type 2	L3	Type 2	SM	FC-APC
D	131AJ	107751695	8-lead	Analog	Type 2	L3	Type 2	SM	SC-APC
L	131AL	107874935	8-lead	Analog	Type 3	L5	Type 2	SM	SC-APC
AA	131AM	107874943	8-lead	Analog	Type 2	L3	Type 2	SM	SC-APC
N	131AN	107874950	8-lead	Digital	Type 1	NA	Type 2	SM	SC-APC
AA	131AP	107874968	8-lead	Analog	Type 2	L3	Type 2	SM	FC-APC
N	131AR	107874976	8-lead	Digital	Type 1	NA	Type 2	SM	FC-APC
L	131AS	107874984	8-lead	Analog	Type 3	L5	Type 2	SM	RMS
L	131AT	107874992	8-lead	Analog	Type 3	L5	Type 2	SM	FC-SPC
AA	131AU	108108465	8-lead	Analog	Type 2	L3	Type 2	SM	E-2000
N	131AW	108108473	8-lead	Digital	Type 1	NA	Type 2	SM	E-2000
N	131AY	TBD	8-lead	Digital	Type 1	NA	Type 1	MM	SC-PC

* SM = single mode (~9 μm core); MM = multimode (50 μm core).

Notes

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