To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

NEC

BIPOLAR ANALOG INTEGRATED CIRCUITS
μPC815, μPC816

ULTRA LOW OFFSET VOLTAGE, LOW DRIFT, LOW NOISE HIGH SLEW RATE, WIDEBAND, OPERATIONAL AMPLIFIER

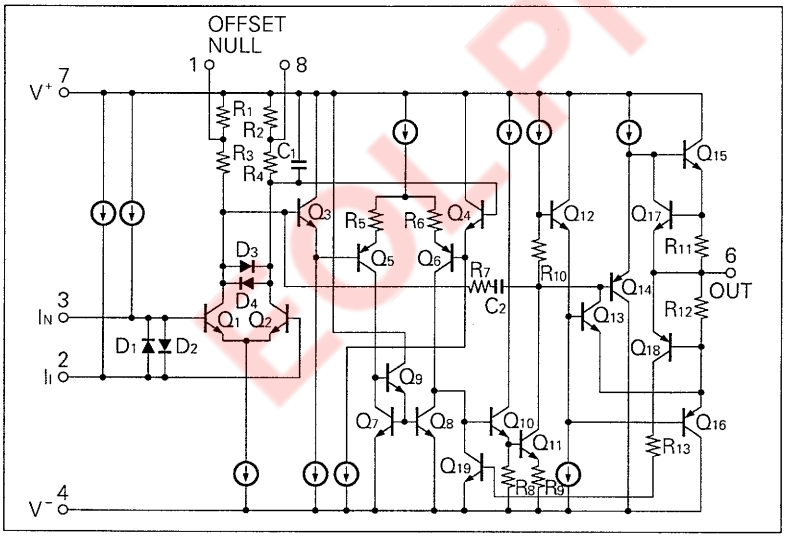
DESCRIPTION

The μPC815, μPC816 are high accuracy OP amps which realize 20 μV input offset voltage and 2.8 nV/$\sqrt{Hz}$ input noise by using advanced on-chip resistor trimming technique and ultra low noise NPN transistor for input stage. The μPC816, high speed version of the μPC815, realizes 25 MHz bandwidth and 7 V/μs slewrate with full frequency compensation characteristics by the effect of output stage high speed PNP transistors. Input stage I_B canceling circuits which minimize-input bias current are also distinctive feature. By these features, the μPC815, μPC816 are optimum choice for instrumentation amplifier, audio pre-amplifier and buffer amplifier for high resolution DAC.

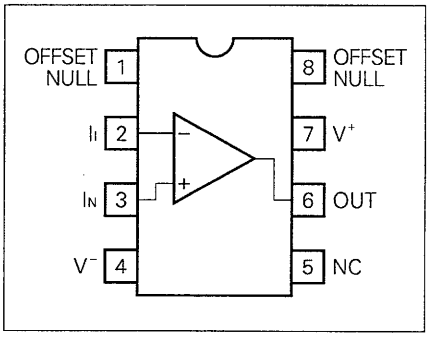
FEATURES

- Wide supply voltage range: ±3 to ±22 V
- Ultra low offset voltage: ±20 μV TYP.
- Ultra low offset voltage drift: ±0.3 μV/°C TYP. (unnull)
- Ultra low noise: 2.8 nV/$\sqrt{Hz}$ (TYP.) (fo = 10 Hz)
- High slew-rate: μPC815: 1.6 V/μs TYP. (A_V = 1)
  μPC816: 7.6 V/μs TYP. (A_V = 1)
- Wide bandwidth product:
  μPC815: 7 MHz TYP. (fo = 100 kHz)
  μPC816: 25 MHz TYP. (fo = 100 kHz)
- Low input bias current: ±10 nA TYP.
- Internal full frequency compensation
- Stable operation under capacitive load:
  μPC815: 100 pF
  μPC816: 1 000 pF

EQUIVALENT CIRCUIT



CONNECTION DIAGRAM (Top View)



ORDERING INFORMATION

PART NUMBER	PACKAGE	QUALITY GRADE
μPC815D	8 PIN CERAMIC DIP (300 mil)	Standard
μPC815D(1)		Standard
μPC815C	8 PIN PLASTIC DIP (300 mil)	Standard
μPC815C(1)		Standard
μPC816D	8 PIN CERAMIC DIP (300 mil)	Standard
μPC816C	8 PIN PLASTIC DIP (300 mil)	Standard

Please refer to "Quality grade on NEC Semiconductor Devices" (Document number IEI-1209) published by NEC Corporation to know the specification of quality grade on the devices and its recommended applications.

Document No. IC-2120A
(O.D. No. IC-5456A)
Date Published March 1993 M
Printed in Japan

ABSOLUTE MAXIMUM RATINGS (T_a = 25 °C)

PARAMETER	SYMBOL	μPC815D	μPC815C	μPC816D	μPC816C	UNIT
Voltage between V^+ and V^- (Note 1)	$V^+ - V^-$	−0.3 to +44				V
Differential Input Current	I_{ID}	±25				mA
Input Voltage (Note 2)	V_I	V^- −0.3 to V^+ +0.3				V
Output Voltage (Note 3)	V_O	V^- −0.3 to V^+ +0.3				V
Power Dissipation	P_T	500 (Note 4)	350 (Note 5)	500 (Note 4)	350 (Note 5)	mW
Output Short Circuit Duration (Note 6)		Indefinite				sec
Operating Temperature Range	T_{opt}	−20 to +80	−20 to +70	−20 to +80	−20 to +70	°C
Storage Temperature Range	T_{stg}	−55 to +150	−55 to +125	−55 to +150	−55 to +125	°C

Note 1. Reverse connection of supply voltage can cause destruction.

Note 2. The input voltage should be allowed to input without damage or destruction. Even during the transition period of supply voltage, power on/off etc., this specification should be kept. The normal operation will establish when the both inputs are within the Common Mode Input Voltage Range of electrical characteristics.

Note 3. This specification is the voltage which should be allowed to supply to the output terminal from external without damage or destructive. Even during the transition period of supply voltage, power on/off etc., this specification should be kept. The output voltage of normal operation will be the Output Voltage Swing of electrical characteristics.

Note 4. Thermal derating factor is −5.0 mV / °C when ambient temperature is higher than 50 °C.

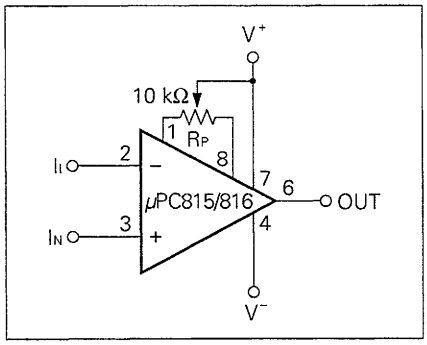
Note 5. Thermal derating factor is −5.0 mV / °C when ambient temperature is higher than 55 °C.

Note 6. Pay careful attention to the total power dissipation not to exceed the absolute maximum ratings, Note 4 and Note 5.

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage		$V^{\pm}$	± 3	± 15	± 20	V
Output Current		I_O			± 25	mA
Capacitive Load (A_V = +1, R_f = 0 Ω)	μPC815	C_L			1000	pF
	μPC816				100	

OFFSET VOLTAGE NULL CIRCUIT



ELECTRICAL CHARACTERISTICS ($V^{\pm}$ = ±15 V, T_a = 25 °C)

CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage		V_{IO}		±20	±60	μV	$R_S \leqq 100\ \Omega$
Input Offset Current		I_{IO}		±7	±50	nA	
Input Bias Current		I_B		±10	±55	nA	
Input Resistance – Common Mode		R_{inCM}		3		GΩ	
Large Signal Voltage Gain		A_v	5	20		V/μV	$R_L \geqq 2\ k\Omega$, V_O = ±12 V
Supply Current		I_{CC}		3.0	4.6	mA	I_O = 0 A
Common Mode Rejection Ratio		CMR	110	130		dB	
Supply Voltage Rejection Ratio		SVR	106	126		dB	$V^{\pm}$ = ±3 V → ±18 V
Output Voltage Swing		V_{om}	±12.5	+13.5 −14.0		V	$R_L \geqq 2\ k\Omega$
			±10.5	+12.5 −13.5			$R_L \geqq 600\ \Omega$
Common Mode Input Voltage Range		V_{ICM}	±11	+12.5 −13.5		V	
Slew Rate	μPC815	SR	0.8	1.6		V/μs	R_L = 2 kΩ
	μPC816		3	7.6			R_L = 2 kΩ
Gain Bandwidth Product	μPC815	GBW	4	7		MHz	f_O = 100 kHz
	μPC816		15	25			f_O = 100 kHz
Input Equivalent Noise Voltage		N_L		0.06	0.13	μV_{p-p}	R_S = 100 Ω, f = 0.1 to 10 Hz
Input Equivalent Noise Voltage Density		e_n		2.8	4.5	$nV/\sqrt{Hz}$	f_O = 10 Hz
				2.7	4.0		f_O = 100 Hz
				2.7	3.8		f_O = 1 000 Hz
Input Equivalent Noise Current Density		i_n		1.5	4.0	$pA/\sqrt{Hz}$	f_O = 10 Hz
				0.4	0.6		f_O = 1 000 Hz
V_{IO} Adjustment Range				±3		mV	R_P = 10 kΩ
Long Term V_{IO} Stability (Note 7)				±0.2	±1.0	μV/Mo	

Note 7. Long term input offset voltage stability refers to the average trend line of offset vs. time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{IO} during 30 days are typically 2.5 μV – refer to typical performance curve.

−20 ≦ T_a ≦ 80 °C (μPC815D, 816D), −20 ≦ T_a ≦ 70 °C (μPC815C, 816C), $V^{\pm}$ = ±15 V

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Input Offset Voltage	V_{IO}		±20	±110	μV	$R_S \leqq 100\ \Omega$
Input Offset Current	I_{IO}		±7	±70	nA	
Input Bias Current	I_B		±10	±75	nA	
Large Signal Voltage Gain	A_v	2.5	20		V/μV	$R_L \geqq 2\ k\Omega$, V_O = ±10 V
Supply Current	I_{CC}		3	5	mA	
Common Mode Rejection Ratio	CMR	106	130		dB	$V^{\pm}$ = ±3 V → ±18 V
Supply Voltage Rejection Ratio	SVR	102	126		dB	$R_L \geqq 2\ k\Omega$
Output Voltage Swing	V_{om}	±12	+13.5 −14.0		V	
Common Mode Input Voltage Range	V_{ICM}	±10.5	+12.5 −13.5		V	
Average V_{IO} Temperature Drift	$\Delta V_{IO}/\Delta T$		±0.3	±1.5	μV/°C	$R_S \leqq 100\ \Omega$

The μPC815D(1) & 815C(1) are temperature drift sorted for high accuracy application. The $\Delta V_{IO}/\Delta T$ spec is shown below.

μPC815D(1), 815C(1)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Average V_{IO} Temperature Drift	$\Delta V_{IO}/\Delta T$			±0.8	μV/°C	$R_S \leqq 100\ \Omega$

APPLICATION INFORMATION

1. Over differential input voltage application

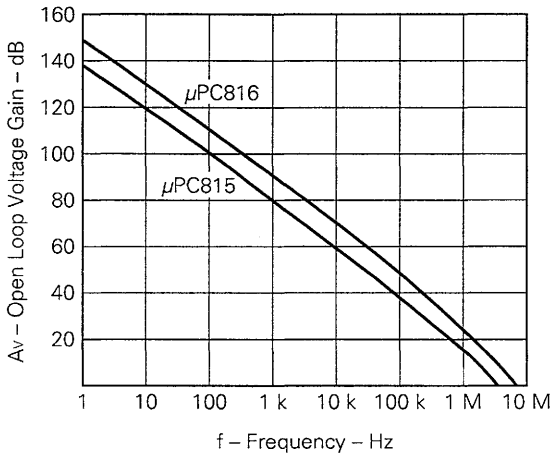
   The μPC815/816 contain the input protection back-to-back diodes at input stage. However the input current limit resistors are not used in order to achieve ultra low noise. (See EQUIVALENT CIRCUIT)
   Therefore, when the over differential input voltage is applied, the differential input current should be kept less than 25 mA by inserting the series resistors at the inputs.

2. Unity gain buffer application

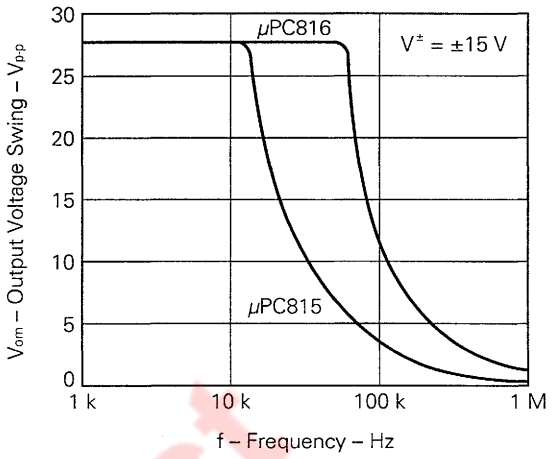
   When the input is driven faster than the Slew Rate under the condition of R_f & $R_S = 0\ \Omega$, the input protection diodes will short the input to the output, and the input current is limited only by the output drive capability. The solution of this problem is inserting the feedback resistor $R_f \gg 1\ k\Omega$, or the source resistor $R_S \gg 1\ k\Omega$ to limit the input short current.
   If the feedback resistor R_f becomes bigger, a pole created with R_f and C_{in} (input capacitance) at $f = \frac{1}{2\pi R_f C_{in}}$ reduces the phase margin. Considering the worst case, the oscillation will occur.
   The solution of this problem is connecting the small capacitor (several 10 pF) in parallel with R_f.

TYPICAL PERFORMANCE CHARACTERISTICS (T_a = 25 °C)

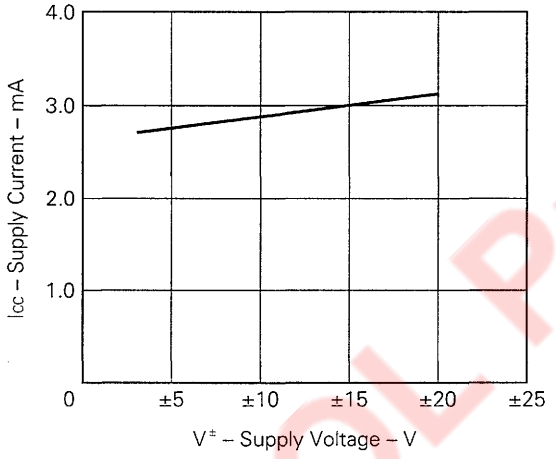
OPEN LOOP FREQUENCY RESPONSE



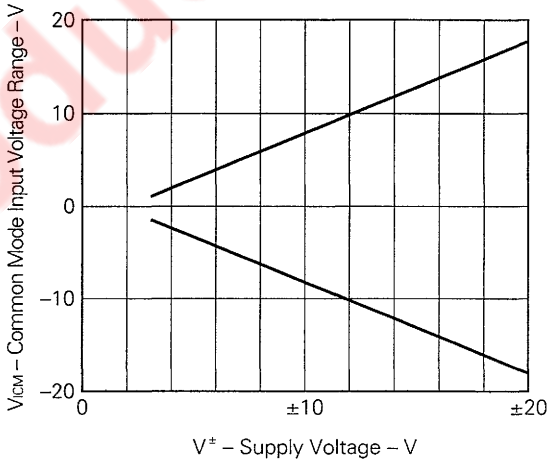
LARGE SIGNAL FREQUENCY RESPONSE



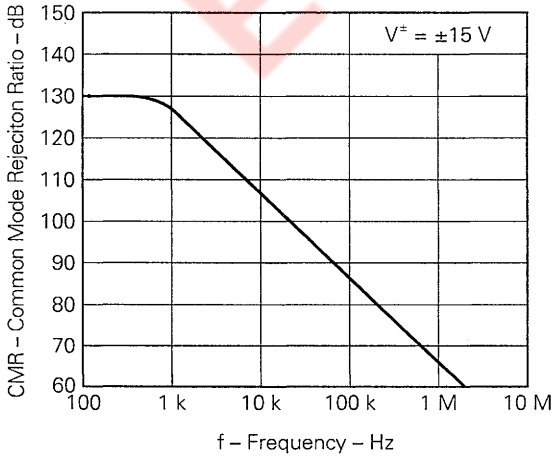
SUPPLY CURRENT



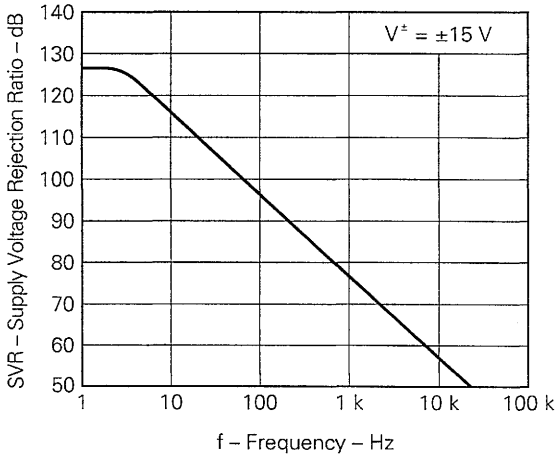
COMMON MODE INPUT VOLTAGE RANGE



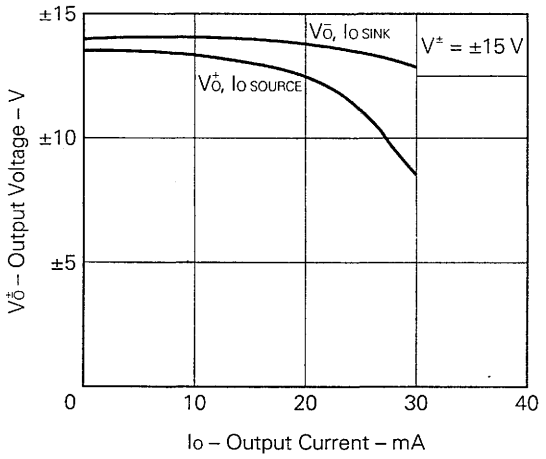
COMMON MODE REJECTION RATIO



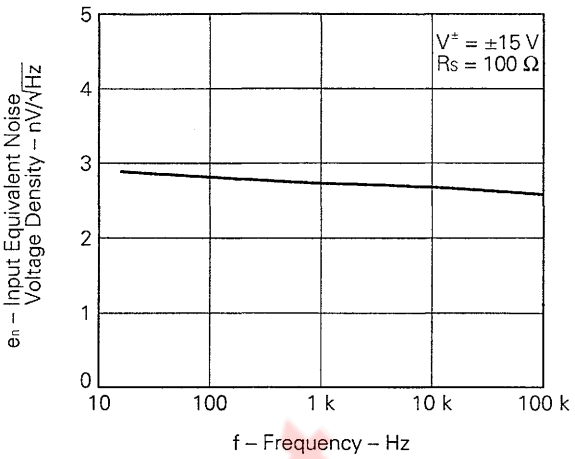
SUPPLY VOLTAGE REJECTION RATIO



OUTPUT CURRENT LIMIT

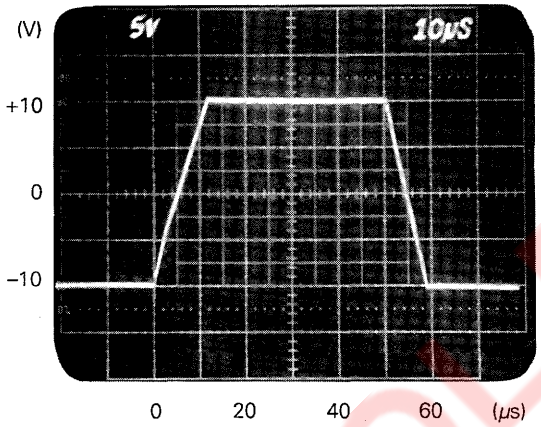


INPUT EQUIVALENT NOISE VOLTAGE DENSITY



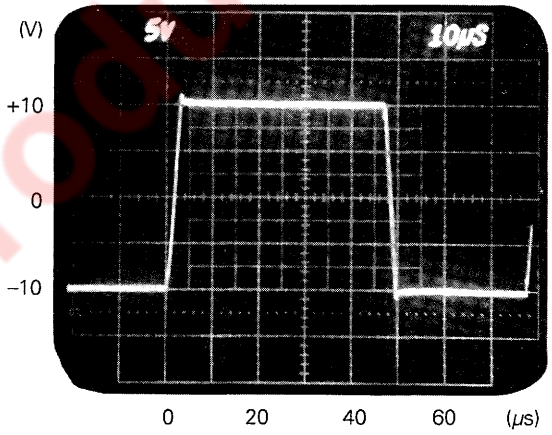
VOLTAGE FOLLOWER PULSE RESPONSE μPC815

(V± = ±15 V, AV = +1)
(Rf = 1 kΩ, RL = 2 kΩ)

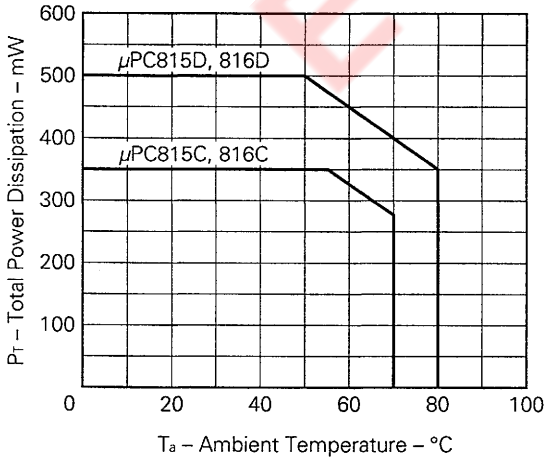


VOLTAGE FOLLOWER PULSE RESPONSE μPC816

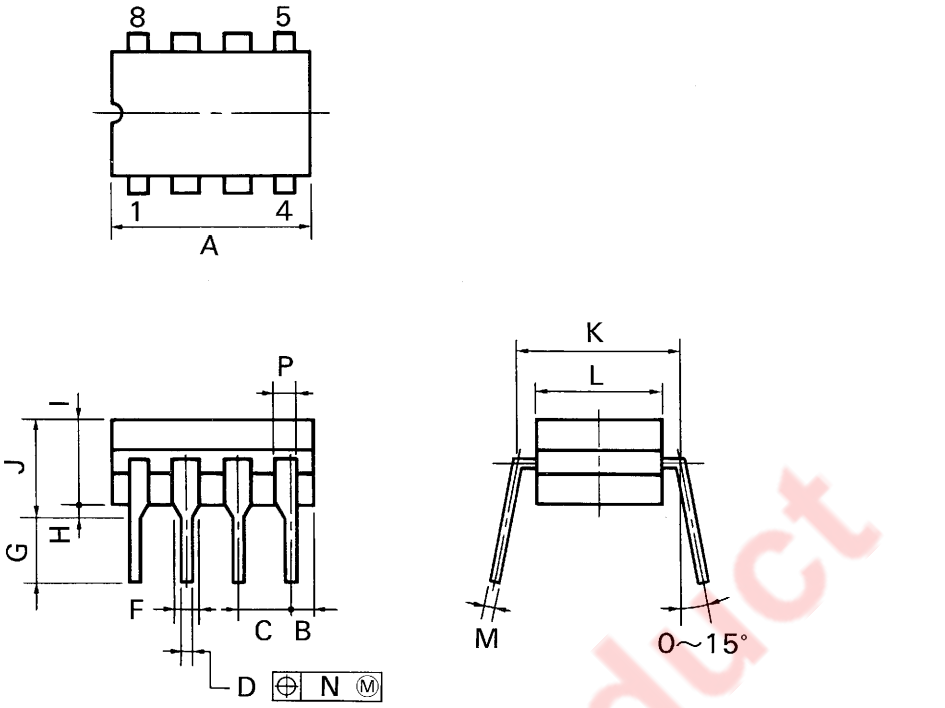
(V± = ±15 V, AV = +1)
(Rf = 1 kΩ, RL = 2 kΩ)



POWER DISSIPATION



8PIN CERAMIC DIP (300 mil)



P8DH-100-300A,B

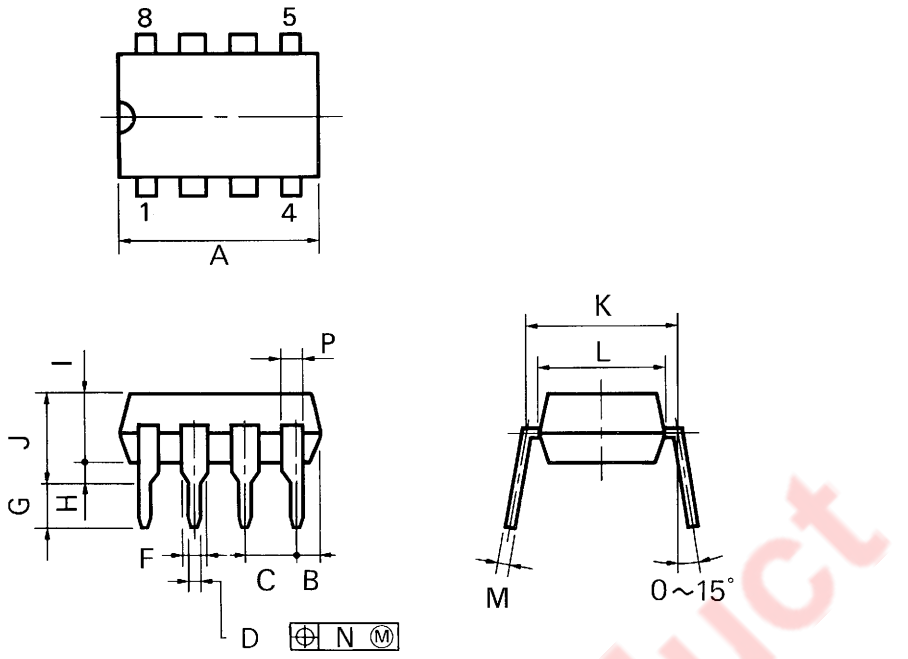
NOTES

1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition

2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	10.16 MAX.	0.400 MAX.
B	1.27 MAX.	0.050 MAX.
C	2.54 (T.P.)	0.100 (T.P.)
D	$0.46^{\pm 0.05}$	$0.018^{\pm 0.002}$
F	1.42 MIN.	0.055 MIN.
G	$3.0^{\pm 0.3}$	$0.118^{\pm 0.012}$
H	0.51 MIN.	0.020 MIN.
I	3.80	0.150
J	5.08 MAX.	0.200 MAX.
K	7.62 (T.P.)	0.300 (T.P.)
L	6.30	0.248
M	$0.25^{\pm 0.05}$	$0.010^{+0.002}_{-0.003}$
N	0.25	0.01
P	0.89 MIN.	0.035 MIN.

8PIN PLASTIC DIP (300 mil)



P8C-100-300B,C

NOTES

1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	10.16 MAX.	0.400 MAX.
B	1.27 MAX.	0.050 MAX.
C	2.54 (T.P.)	0.100 (T.P.)
D	$0.50^{+0.10}$	$0.020^{+0.004}_{-0.005}$
F	1.4 MIN.	0.055 MIN.
G	$3.2^{\pm0.3}$	$0.126^{+0.012}$
H	0.51 MIN.	0.020 MIN.
I	4.31 MAX.	0.170 MAX.
J	5.08 MAX.	0.200 MAX.
K	7.62 (T.P.)	0.300 (T.P.)
L	6.4	0.252
M	$0.25^{+0.10}_{-0.05}$	$0.010^{+0.004}_{-0.003}$
N	0.25	0.01
P	0.9 MIN.	0.035 MIN.

RECOMMENDED SOLDERING CONDITIONS

The following conditions (see table below) must be met when soldering this product.
Please consult with our sales offices in case other soldering process is used, or in case soldering is done under different conditions.

TYPES OF THROUGH HOLE DEVICE

[μPC815D, μPC815C, μPC816D, μPC816C]

Soldering method	Soldering conditions	Recommended condition symbol
Wave soldering	Solder temperature: 260 °C or below, Flow time: 10 seconds or below	

[MEMO]