

SPECIFICATIONS

(typical @ +25°C and $V_S = +15V$ dc unless otherwise noted)

MODEL	284J	286J ¹
GAIN (NON-INVERTING)		
Range (50kΩ Load)	1 to 10V/V	1 to 100V/V
Formula	$Gain = \left[1 + \frac{100k\Omega}{10.7k\Omega + R_i(k\Omega)} \right]$	$Gain = \left[1 + \frac{100k\Omega}{1k\Omega + R_i(k\Omega)} \right]$
Deviation from Formula vs. Time	±3%	±4%
vs. Temperature (0 to +70°C) ²	±0.001%/1000 Hours	*
Nonlinearity, 10V pk-pk Output ²	±0.0075%/°C	*
	±0.05%	*
INPUT VOLTAGE RATINGS		
Linear Differential Range, $G = 1V/V$	±5V min	±10V min
Max Safe Differential Input		
Continuous	240V _{rms}	*
Pulse, 10ms duration, 1 pulse/10 sec ³	±6500V _{pk} max	*
Max CMV, Inputs to Outputs		
AC, 60Hz, 1 minute duration	2500V _{rms}	*
Pulse, 10ms duration, 1 pulse/10 sec ³	±2500V _{pk} max	*
With 510kΩ in series with Guard	±5000V _{pk} max	*
Continuous, AC or DC	±2500V _{pk}	*
CMR, Inputs to Outputs, 60Hz, $R_S \leq 5k\Omega$		
Balanced Source Impedance	114dB	*
5kΩ Source Impedance Imbalance	110dB min	*
CMR, Inputs to Guard, 60Hz		
1kΩ Source Impedance Imbalance	78dB	*
Max Leakage Current, Inputs to Power Common @ 115VAC, 60Hz	2.0μA rms max	2.5μA rms max
INPUT IMPEDANCE		
Differential	10 ⁸ Ω 70pF	10 ⁸ Ω 150pF
Overload	300kΩ	*
Common Mode	5x10 ¹⁰ Ω 20pF	*
INPUT DIFFERENCE CURRENT		
Initial, @ +25°C	±7nA max	*
vs. Temperature (0 to +70°C)	±0.1nA/°C	*
INPUT NOISE		
Voltage ⁴		
0.05Hz to 100Hz	8μV pk-pk	*
10Hz to 1kHz	10μV rms	3μV rms
Current		
0.05Hz to 100Hz	5pA pk-pk	*
FREQUENCY RESPONSE		
Small Signal, -3dB	1kHz	*
Slew Rate	25mV/μs	*
Full Power, 10V p-p Output	200Hz	900Hz
Full Power, 20V p-p Output	N/A	400Hz
Recovery Time, to ±100μV after Application of ±6500V _{pk} Differential Input Pulse ³	200ms	*
OFFSET VOLTAGE REFERRED TO INPUT		
Initial, @ +25°C, Adjustable to Zero vs. Temperature (0 to +70°C)	±(5 + 20/G)mV	±(5 + 45/G)mV
vs. Supply Voltage	±(1 + 150/G)μV/°C	±(7 + 250/G)μV/°C
	±1mV/%	*
RATED OUTPUT		
Voltage, 50kΩ Load	±5V min	±10V min
Output Impedance	1kΩ	*
Output Ripple, 1MHz Bandwidth	5mV pk-pk	20mV pk-pk
ISOLATED POWER OUTPUTS		
Voltage, ±5mA Load	±8.5V dc	±15V dc
Accuracy	±5%	0, -6%
Current	±5mA min	±15mA min
Regulation, No Load to Full Load	+0, -15%	+0, -10%
Ripple, 100kHz Bandwidth	100mV pk-pk	200mV pk-pk
POWER SUPPLY, SINGLE POLARITY⁵		
Voltage, Rated Performance	+15V dc	*
Voltage Operating	+(8 to 15.5)V dc	*
Current, Quiescent	+10mA	+13mA
TEMPERATURE RANGE		
Rated Performance	0 to +70°C	*
Operating	-25°C to +85°C	*
Storage	-55°C to +85°C	*
CASE DIMENSIONS⁶		
	1.5" x 1.5" x 0.62"	*

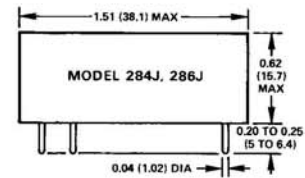
NOTES

- *Specifications same as model 284J.
- ¹Specifications for model 286J apply when driven by ADI model 281 oscillator.
- ²Gain temperature drift and gain nonlinearity are specified as a percentage of output signal level.
- ³Rise time of pulse must be >10μs.
- ⁴Model 284J: Gain = 10V/V; Model 286J: Gain = 100V/V.
- ⁵Recommended power supply, ADI model 904, ±15V @ 50mA.
- ⁶Recommended mounting sockets - model 284J: ADI Part Number AC1049; model 286J: ADI Part Number AC1054.

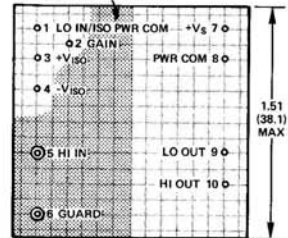
Specifications subject to change without notice.

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



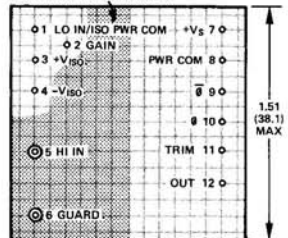
FOR GUARDING TECHNIQUES SEE FIGURE 3



BOTTOM VIEW WEIGHT: 40 G

Model 284J

FOR GUARDING TECHNIQUES SEE FIGURE 4



BOTTOM VIEW WEIGHT: 40 G

Model 286J

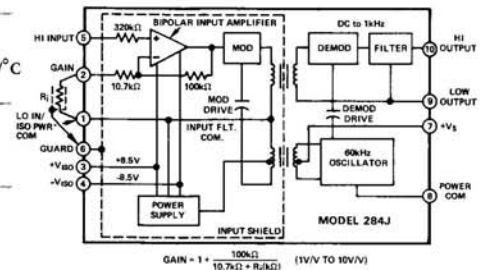


Figure 1. Block Diagram - Model 284J

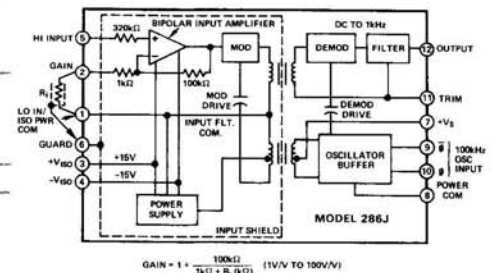
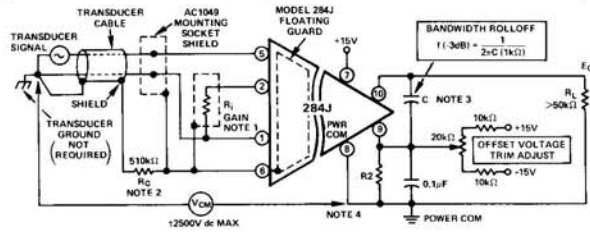


Figure 2. Block Diagram - Model 286J

Understanding the Isolation Amplifier Performance

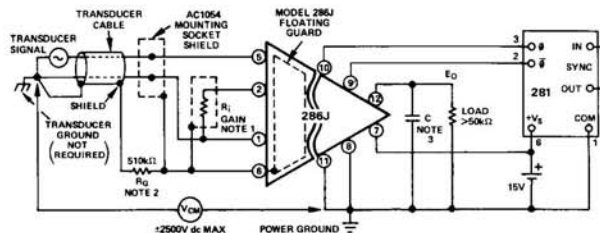
INTERCONNECTION AND GUARDING TECHNIQUES

Models 284J, 286J can be applied directly to achieve rated performance as shown in Figures 3 and 4. To preserve the high



- NOTE 1.** GAIN RESISTOR, R_1 , 1%, 50ppm/°C METAL FILM TYPE IS RECOMMENDED. FOR GAIN = 1V/V, LEAVE TERMINAL 2 OPEN. FOR GAIN = 10V/V, SHORT TERMINAL 2 TO TERMINAL 1
- $$\text{GAIN} = 1 + \frac{100k\Omega}{10.7k\Omega + R_1(k\Omega)}$$
- NOTE 2.** GUARD RESISTOR, R_G , REQUIRED ONLY FOR CMV > ±2500V_{PK} (±5kV_{PK} MAX). R_G MAY BE MOUNTED ON AC1049 MOUNTING SOCKET USING STANDOFF PROVIDED. (USE ¼ WATT, 5%, CARBON COMPOSITION TYPE; ALLEN BRADLEY RECOMMENDED).
- NOTE 3.** OUTPUT FILTER CAPACITOR, C, SELECT TO ROLL OFF NOISE AND OUTPUT RIPPLE. (e.g. SELECT C = 1.5µF FOR dc TO 100Hz BANDWIDTH).
- NOTE 4.** $R_2 \sim 200\Omega$, $G = 1$; $R_2 \sim 2k\Omega$, $G > 1$

Figure 3. Model 284J Basic Isolator Interconnection



- NOTE 1.** GAIN RESISTOR, R_1 , USE 50ppm/°C, METAL FILM TYPE. FOR GAIN = 1V/V, LEAVE TERMINAL 2 OPEN. FOR GAIN = 100V/V, SHORT TERMINAL 2 TO TERMINAL 1 FOR GAINS FROM 1V/V TO 100V/V:
- $$\text{GAIN} = 1 + \frac{100k\Omega}{1k\Omega + R_1(k\Omega)}$$
- NOTE 2.** OPTIONAL GUARD RESISTOR, R_G , REQUIRED ONLY FOR CMV > ±2500V_{PK}. R_G MAY BE CONVENIENTLY MOUNTED ON AC1054 MOUNTING SOCKET USING THE STANDOFF PROVIDED (R_G). USE ¼ WATT, 5% CARBON COMPOSITION TYPE; (ALLEN BRADLEY RECOMMENDED).
- NOTE 3.** OUTPUT FILTER CAPACITOR C, SELECT TO ROLL OFF NOISE AND OUTPUT RIPPLE. (e.g. SELECT C = 1.5µF FOR dc TO 100Hz BANDWIDTH)
- $$f(-3dB) = \frac{1}{2\pi C(1k\Omega)}$$

Figure 4. Model 286J Basic Isolator Interconnection

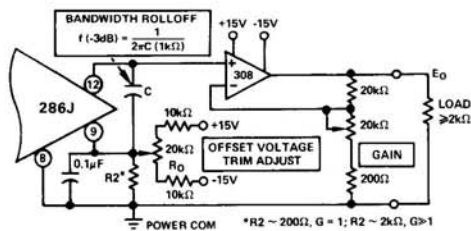


Figure 5. Model 286J Optional Connection: Offset Voltage Trim Adjust, Bandwidth (-3dB) Roll-off and Gain Adjust ($G > 100V/V$)

CMR performance, care must be taken to keep the capacitance balanced about the input terminals. A shield should be provided on the printed circuit board under model 284J or 286J. The GUARD (Pin 6) should be connected to this shield. The guard-shield is provided with the mounting socket. To reduce effective cable capacitance, cable shield should be connected to the common mode signal source by connecting the shield as close as possible to the signal low.

Offset Voltage Trim Adjust: The trim adjust circuits shown in Figures 3 and 5 can be used to zero the output offset voltage over the specified gain range. The output terminals, HI OUT and LO OUT, can be floated with respect to PWR COM up to ±50V_{PK} max, offering three-port isolation. A 0.1µF capacitor is required from LO OUT to PWR COM whenever the output terminals are floated with respect to PWR COM. LO OUT can be connected directly to PWR COM when output offset trimming is not required.

INTERELECTRODE CAPACITANCE, TERMINAL RATINGS AND LEAKAGE CURRENTS LIMITS

Capacitance: Interelectrode terminal capacitance arising from stray coupling capacitance effects between the input terminals and the signal output terminals are each shunted by leakage resistance values exceeding 50kΩ. Figures 6 and 8 illustrate the CMR ratings at 60Hz and 5kΩ source imbalance between signal input/output terminals, along with their respective capacitance.

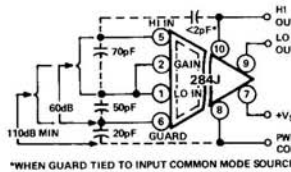


Figure 6. Model 284J Terminal Capacitance and CMR Ratings

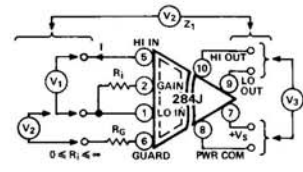


Figure 7. Model 284J Terminal Ratings

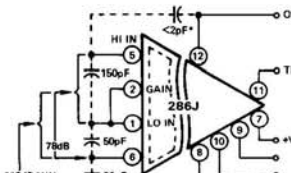


Figure 8. Model 286J Terminal Capacitance and CMR Ratings

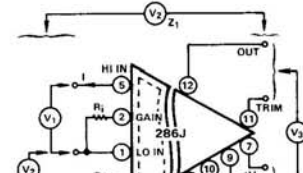


Figure 9. Model 286J Terminal Ratings

Terminal Ratings: CMV performance is given in both peak pulse and continuous ac or dc peak ratings. Pulse ratings are intended to support defibrillator and other transient voltages. Continuous peak ratings apply from dc up to the normal full power response frequencies. Figures 7 and 9 and Table 1 illustrate models 284J, 286J ratings between terminals.

SYMBOL	RATING	REMARKS
V1 (pulse)*	±6500V _{PK} (10ms)	Withstand Voltage, Defibrillator
V1 (cont.)	±240V _{RMS}	Withstand Voltage, Steady State
V2 (pulse)*	±2500V _{PK} (10ms) $R_G = 0$	Transient
V2 (pulse)*	±5000V _{PK} (10ms) $R_G = 510k\Omega$	Isolation, Defibrillator
V2 (cont.)	±2500V _{PK}	Isolation, Steady State
V3 (cont.)	±50V _{PK}	Isolation, dc
Z1	50kΩ 20pF	Isolation Impedance
I (286J)	50µA rms	Input Fault Limit, dc to 200kHz
I (284J)	35µA rms	Input Fault Limit, dc to 60kHz

*Rise time of pulse must be > 10µs.

Table 1. Isolation Ratings Between Terminals

Leakage Current Limits: The low coupling capacitance between inputs and output yields a ground leakage current of less than 2.0 μ A rms (284J) and 2.5 μ A rms (286J) at 115V ac, 60Hz (or 0.02 μ A/V ac). As shown in Figures 10 and 11, the transformer coupled modulator signal, through stray coupling, also creates an internally generated leakage current. Line frequency leakage current levels are unaffected by the power on or off condition of models 284J, 286J.

For medical applications, models 284J and 286J are designed to improve on patient safety current limits proposed by F.D.A., U.L., A.A.M.I. and other regulatory agencies (e.g., model 286J complies with leakage requirements for the Underwriters Laboratory STANDARD FOR SAFETY, MEDICAL AND DENTAL EQUIPMENT as established under UL544 for type A and B patient connected equipment – reference *Leakage Current*, paragraph 27.5).

In patient monitoring equipment, such as ECG recorders, models 284J, 286J will provide adequate isolation without exposing the patient to potentially lethal microshock hazards. Using passive components for input protection, this design limits input fault currents even under amplifier failure conditions.

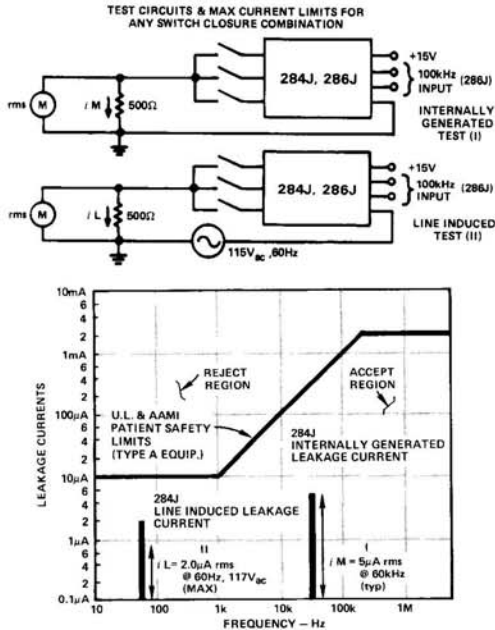


Figure 10. Model 284J Leakage Current Performance from Line Induced and Internally Generated (Modulator) Operating Conditions

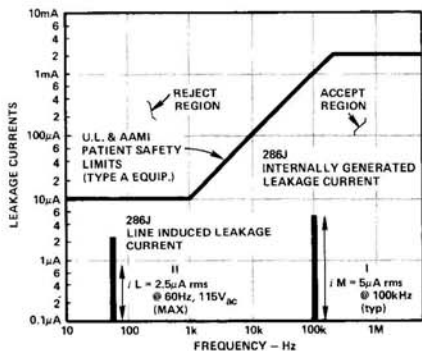


Figure 11. Model 286J Leakage Current Performance from Line Induced and Internally Generated (Modulator) Operating Conditions

GAIN AND OFFSET TRIM PROCEDURE, MODEL 284J

1. Apply $e_{IN} = 0$ volts and adjust R_O for $e_O = 0$ volts.
2. Apply $e_{IN} = +1.000V$ dc and adjust R_G for $e_O = +5.000V$ dc.
3. Apply $e_{IN} = -1.000V$ dc and measure the output error (see curve a).
4. Adjust R_G until the output error is one half that measured in step 3 (see curve b).
5. Apply $e_{IN} = +1.000V$ dc and adjust R_O until the output error is one half that measured in step 4 (see curve c).

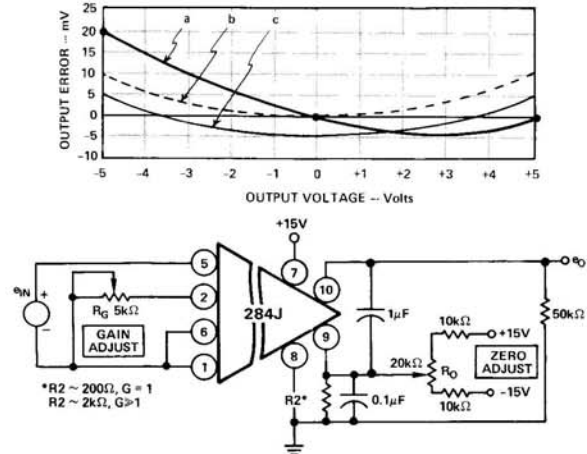


Figure 12. Gain and Offset Adjustment

GAIN AND OFFSET TRIM PROCEDURE, MODEL 286J

In applying the isolation amplifier, highest accuracy is achieved by adjustment of gain and offset voltage to minimize the peak error encountered over the selected output voltage span. The following procedure illustrates a calibration technique which can be used to minimize output error. In this example, the output span is +5V to -5V and operation at Gain = 10V/V is desired.

1. Apply $e_{IN} = 0$ volts and adjust R_O for $e_O = 0$ volts.
2. Apply $e_{IN} = +0.500V$ dc and adjust R_G for $e_O = +5.000V$ dc.
3. Apply $e_{IN} = -0.500V$ dc and measure the output error (see curve a).
4. Adjust R_G until the output error is one half that measured in step 3 (see curve b).
5. Apply $+0.500V$ dc and adjust R_O until the output error is one half that measured in step 4 (see curve c).

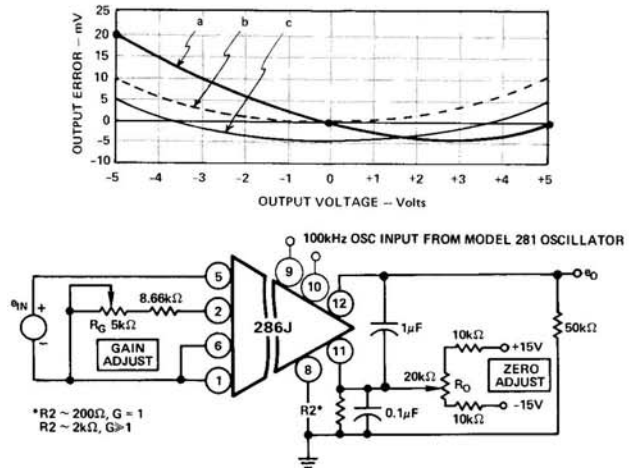


Figure 13. Gain and Offset Adjustment

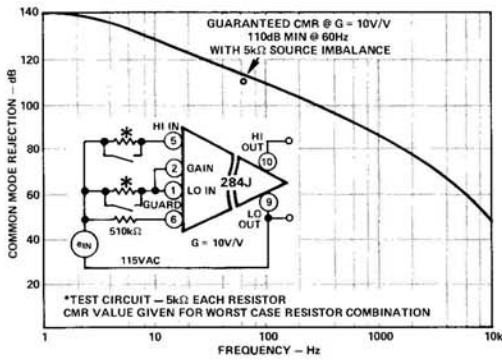


Figure 14. Model 284J Common Mode Rejection vs. Frequency

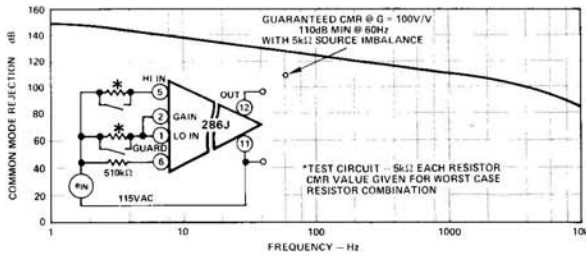


Figure 15. Model 286J Common Mode Rejection vs. Frequency

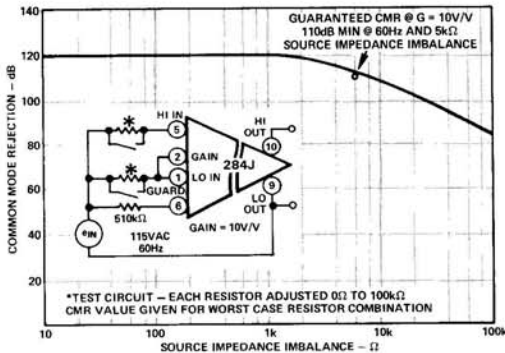


Figure 16. Model 284J Common Mode Rejection vs. Source Impedance Imbalance

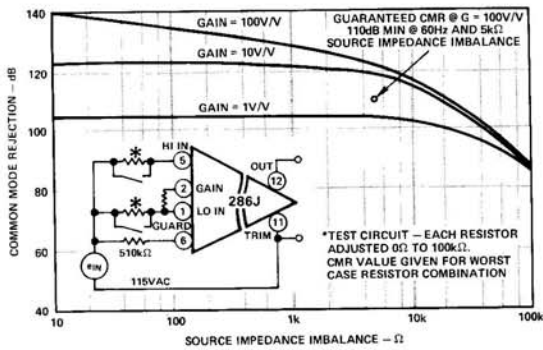


Figure 17. Model 286J Common Mode Rejection vs. Source Impedance Imbalance

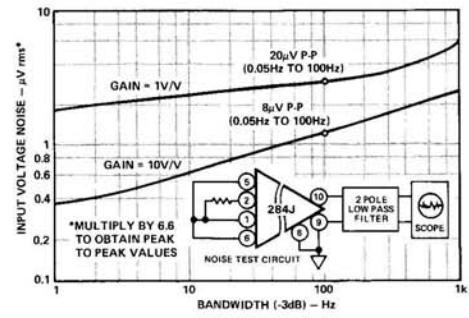


Figure 18. Model 284J Input Voltage Noise vs. Bandwidth

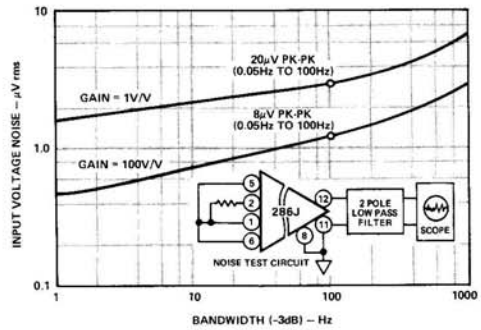


Figure 19. Model 286J Input Voltage Noise vs. Bandwidth

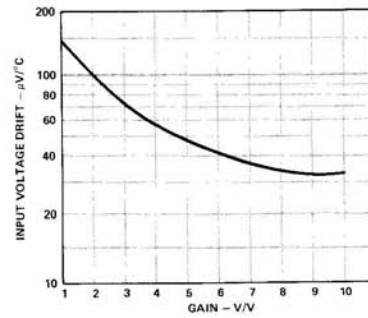


Figure 20. Model 284J Input Offset Voltage Drift vs. Gain

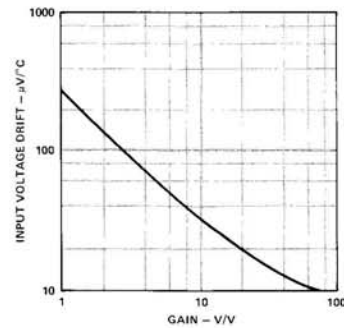


Figure 21. Model 286J Input Offset Voltage Drift vs. Gain

Applying the Multi-Channel Isolation Amplifier

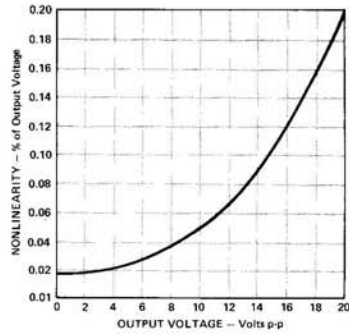
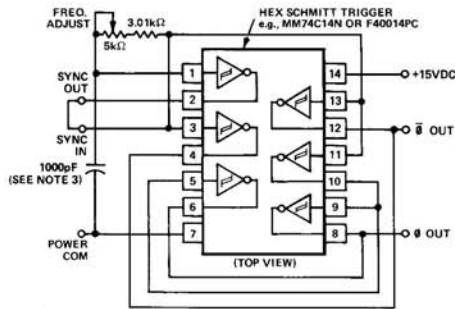


Figure 22. Model 286J Gain Nonlinearity vs. Output Voltage

REFERENCE EXCITATION OSCILLATOR*

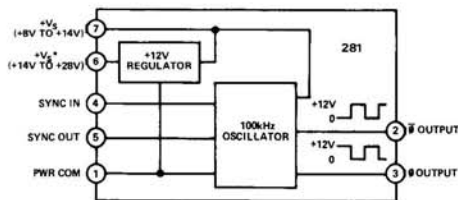
When applying model 286J, the user has the option of building a low cost 100kHz excitation oscillator, as shown in Figure 23, or purchasing a module from Analog Devices – model 281.



NOTES:
 1. FREQ. ADJUST: ADJUST TRIM POT FOR OUTPUT FREQUENCY OF 100kHz ±5%.
 2. FOR SLAVE OPERATION, REMOVE JUMPER FROM SYNC OUT AND SYNC IN PINS.
 3. USE CERAMIC CAPACITOR, "COG" OR "NPO" CHARACTERISTIC.

Figure 23. Model 281 100kHz Oscillator – Logic and Interconnection Diagram

The block diagram of model 281 is shown in Figure 24. An internal +12V dc regulator is provided to permit the user the option of operating over two, pin selectable, power input ranges; terminal 6 offers a range of +14V dc to +28V dc; terminal 7 offers an input range of +8V dc to +14V dc.



*LEAVE TERMINAL 6 OPEN, WHEN POWER IS APPLIED TO TERMINAL 7.

Figure 24. Model 281 Block Diagram

Model 281 oscillator is capable of driving up to 16 model 286Js as shown in Figure 25. An additional model 281 may be driven in a slave-mode, as shown in Figure 26 to expand the total system channels from 16 to 32. By adding additional model 281's in this manner, systems of over 1000 channels may be easily configured.

*CAUTION:

ESD(Electro-static-discharge) sensitive device. Permanent damage may occur on unconnected devices subjected to high-energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. The protective foam should be discharged to the destination socket before devices are removed.

EXTERNAL OSCILLATOR INTERCONNECTION

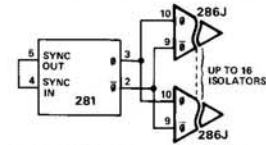


Figure 25. Model 281/286 Connection for Driving from 1 to 16 Isolators

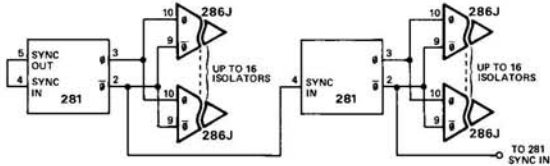


Figure 26. Model 281/286 Connection for Driving > 16 Isolators

SPECIFICATIONS

(typical @ +25° C and V_S = +15V dc unless otherwise noted)

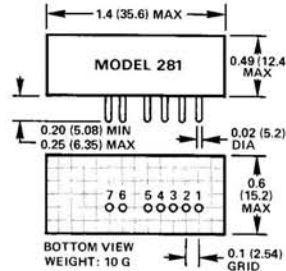
MODEL	281*
OUTPUT	
Frequency	100kHz ±5%
Waveform	Squarewave
Voltage (φ and φ̄ terminals)	0 to +12V pk
Fan-Out ^{1,2}	16 max
POWER SUPPLY RANGE³	
High Input, Pin 6	+(14 to 28)V dc
Quiescent Current, N.L.	+5mA
F.L.	+16mA
Low Input, Pin 7	+(8 to 14)V dc
Quiescent Current, N.L.	+12mA
F.L.	+33mA
TEMPERATURE	
Rated Performance	0 to +70° C
Storage	-55° C to +85° C
MECHANICAL	
Case Size	1.4" x 0.6" x 0.49"
Weight	10 grams

NOTES

- Model 286J oscillator drive input represents unity oscillator load.
 - For applications requiring more than 16 286Js, additional 281s may be used in a master/slave mode. Refer to Figure 26.
 - Full load consists of 16 model 286Js and 281 oscillator slave.
- Specifications subject to change without notice.

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



- PIN TERMINAL IDENTIFICATION**
- POWER COMMON
 - φ OUTPUT
 - φ OUTPUT
 - SYNC INPUT
 - SYNC OUTPUT
 - +V_H: HIGH RANGE +(14 to 28)V_{dc}
 - +V_L: LOW RANGE +(8 to 14)V_{dc}

MATING SOCKET: Cinch #16 DIP or Equivalent



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