

# DATA SHEET

DS-11019

## Matrix Modules [CPM & PAM-16]

- 6 by 8 Analog Switching Matrix
- Full Kelvin Sensing with Guard
- 2A Carry Current
- 600V Standoff Voltage
- Integrated Picoampere Meter with PAM

### System Versatility

Crosspoint matrix (CPM) and picoammeter matrix (PAM) modules provide Reedholm systems with the fundamental capability of connecting any instrument to any DUT pin. Relays are programmable through Reedholm driver software, enabling safe connection of any combination of eight pins with six analog instrumentation nodes. Node 0 is dedicated as analog ground. The other five are fully guarded pathways with separate force and sense lines for accurate delivery of precision voltages at high current. Each module is separately addressable, thereby allowing multiple matrix modules per system.

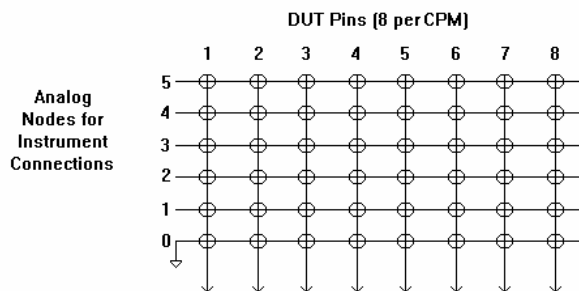


Figure 1 - Crosspoint Matrix Block Diagram

### CPM Specifications

Standoff Voltage	600V Max
Carry Current	2A Max
Series Resistance	200mΩ Max CPM 350mΩ Max PAM
Bandwidth	5MHz Typical
Node Loading	No Pins Connected 30pF Max/Module Pins Connected 30pF per Pin
Leakage Resistance	Any Pin to a PAM Pin $1 \times 10^{15}\Omega$ Pin-to-Pin $1 \times 10^{12}\Omega$ / System Pin Count
Switching Time	1 ms Max
Pin Pair Thermal EMF	100μV Max

### PAM Specifications

PAM-16				
Mode	Range	Measure Error		Resolution
		Offset	% of Value	
Current	100pA	100fA	0.15	6.25fA
	1nA	125fA	0.15	62.5fA
	10nA	1.25pA	0.1	625fA
	100nA	12.5pA	0.1	6.25pA
Accuracy	Specifications apply for 24 hours and $\pm 1C^\circ$ after manual calibration is performed.			
A/D Conversion Time	50ms			
Input Reference Voltage	Fixed at Virtual Ground			
Pin Injection Capacitance	0.15pF			
Maximum Injection Step Without Overload	100pA, 1nA Ranges: $[9/(C_{DUT} + 0.15)]V$			
	10nA, 100nA Ranges: $[585/(C_{DUT} + 0.15)]V$ * $C_{DUT}$ expressed in pF			
Amplifier Overload	Recovery Time: 50ms			
Step Response Time to Within 0.1%	See Figure 4			
Normal Mode Noise Rejection	60dB at 50Hz and 60Hz			
Noise Bandwidth	20Hz			
Input Current	75fA Max			
Input Current Temperature Coefficient	10fA/Degrees C			
Input Referred Noise	7fA RMS (<35fA p-p, 99% of the time)			

## Minimum Effects on Test Results

Matrix modules are as transparent to device testing as possible. Each node-to-pin crosspoint dry reed relay is independent of all others. These high-quality relays built to Reedholm specifications provide an excellent combination of signal transmission, pin isolation, and life expectancy.

### Notable features:

- 1) Form A, three-pole relays allow routing of force, sense, and driven guard signals from any instrument to the DUT for low noise parameter testing.
- 2) Fast relay closure (settling times) of <1 ms.
- 3) High relay life expectancy (>10<sup>8</sup> cycles).
- 4) <200mΩ static resistance over life of relay.

## PAM Module Measurement Capability

The PAM is a superset of the CPM having a very low current node connected to a feedback ammeter.

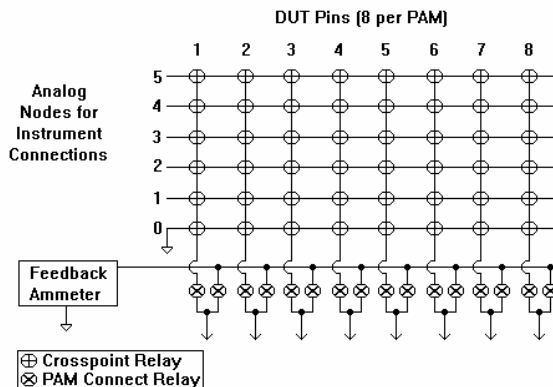


Figure 2 - Picoammeter Block Diagram

## Current Measurement

The feedback ammeter, shown in Figure 3, consists of an electrometer class amplifier whose input voltage is held at virtual ground via the feedback path of  $R_F$  and  $C_F$ . The unknown current  $I_x$  flows through  $R_F$ , creating a voltage equal to  $I_x R_F$  at the amplifier output.

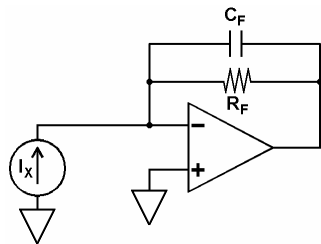


Figure 3 - Feedback Ammeter

## Current Span

A PAM has four current ranges with full-scale values of 100pA, 1nA, 10nA, and 100nA. An integrating ADC with a crystal-controlled clock converts DC output of the feedback ammeter to a digital signal. Integration times are selected to reduce always-present power line noise (50 or 60Hz) by >60dB. Resolution on the lowest range is 6.25fA.

## PAM Analog Cabling

Analog cabling used to connect PAM pins is a proprietary design optimized for minimum tribo- and piezo-electric noise. A fully shielded force/sense pair provides for common matrix measurements that might require current up to 2A.

When a pin is connected to the PAM node for low current measurement, the shield is connected to analog ground to minimize noise and leakage currents. Dielectric absorption effects are minimized by use of the highest quality dielectrics on the PAM node that are always referenced to ground.

## Reedholm Probe Cards

Low leakage measurement accuracy and speed are compromised by the practical limitations imposed by most conventional probe cards. Reedholm low current probe cards are built with multi-layer techniques that completely guard signal traces against surface and bulk leakage currents. Compared to conventional probe cards, their significantly lower dielectric absorption effects permit faster and more accurate measurements.

## Step Response

When the PAM is used to measure current from a non-ideal source having finite source resistance  $R_s$ , the system loop gain is altered, thereby changing the step response characteristics. Those effects are shown in figure 4.

Those figures contain data for three values of source resistance, each shown with two scales so that large step response can be differentiated from settling to within specified accuracy. The three curves on the left use the left scale and three on the right use the expanded right scale, as denoted in the graphs. Not all of the curves are visible due to overlaid data. Source resistance values,  $R_s$ , are provided in graphs.

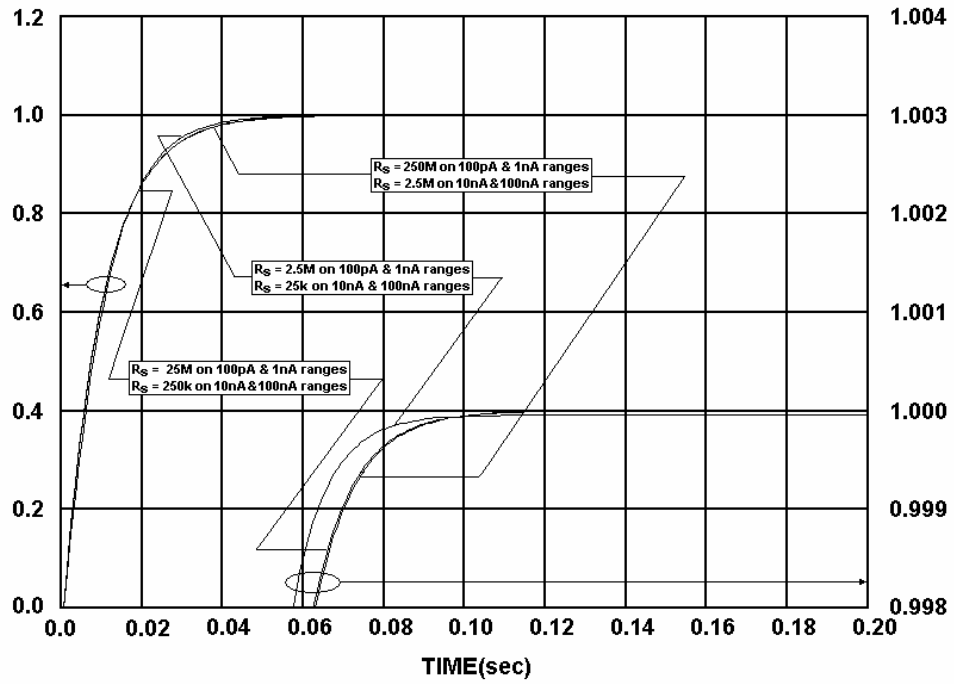


Figure 4 - Normalized Step Response – PAM-16