CALIBRATION AND DECOUPLING MATRIX

All multi-axis sensors have some degree of cross coupling, a condition where a load on one axis produces a change in output on other axes. Each ***JR3*** sensor is individually calibrated with loads on each axis. The calibration data is used to generate a calibration and decoupling matrix, used to convert the output voltages to force and moment loading data. The calibration matrix is provided on the Sensor Specification Sheet for your sensor.

The six by six matrix is multiplied by the six-element voltage vector (column). The result is calibrated force and moment data in the units specified on the Sensor Specification Sheet. The matrix multiplication is most easily performed by a computer, although manual computation is possible.

To find the calibrated, decoupled output, multiply the decoupling matrix by the output channel voltage vector. The output must be scaled to the desired units.

$$\underset{\text{Decoupling matrix}}{\begin{bmatrix} \quad A \quad \end{bmatrix}} \;\mathrm{X}\; \underset{\text{channel output voltage}}{\begin{bmatrix} \text{Volts} \end{bmatrix}} = \underset{\text{decoupled loads}}{\begin{bmatrix} \text{load} \end{bmatrix}}$$

$$\begin{array}{c} \mathrm{Fx} \\ \mathrm{Fy} \\ \mathrm{Fz} \\ \mathrm{Mx} \\ \mathrm{My} \\ \mathrm{Mz} \end{array} \underset{\text{DECOUPLING MATRIX}}{\begin{bmatrix} \mathrm{A1{,}1} & \mathrm{A1{,}2} & \mathrm{A1{,}3} & \mathrm{A1{,}4} & \mathrm{A1{,}5} & \mathrm{A1{,}6} \\ \mathrm{A2{,}1} & \mathrm{A2{,}2} & \mathrm{A2{,}3} & \mathrm{A2{,}4} & \mathrm{A2{,}5} & \mathrm{A2{,}6} \\ \mathrm{A3{,}1} & \mathrm{A3{,}2} & \mathrm{A3{,}3} & \mathrm{A3{,}4} & \mathrm{A3{,}5} & \mathrm{A3{,}6} \\ \mathrm{A4{,}1} & \mathrm{A4{,}2} & \mathrm{A4{,}3} & \mathrm{A4{,}4} & \mathrm{A4{,}5} & \mathrm{A4{,}6} \\ \mathrm{A5{,}1} & \mathrm{A5{,}2} & \mathrm{A5{,}3} & \mathrm{A5{,}4} & \mathrm{A5{,}5} & \mathrm{A5{,}6} \\ \mathrm{A6{,}1} & \mathrm{A6{,}2} & \mathrm{A6{,}3} & \mathrm{A6{,}4} & \mathrm{A6{,}5} & \mathrm{A6{,}6} \end{bmatrix}} \;\mathrm{X}\; \underset{\substack{\text{CHANNEL} \\ \text{VOLTAGE} \\ \text{VECTOR}}}{\begin{bmatrix} \mathrm{C1} \\ \mathrm{C2} \\ \mathrm{C3} \\ \mathrm{C4} \\ \mathrm{C5} \\ \mathrm{C6} \end{bmatrix}} = \underset{\substack{\text{DECOUPLED} \\ \text{OUTPUT}}}{\begin{bmatrix} \mathrm{Fx} \\ \mathrm{Fy} \\ \mathrm{Fz} \\ \mathrm{Mx} \\ \mathrm{My} \\ \mathrm{Mz} \end{bmatrix}}$$

MANUAL CALCULATION:

Matrix calculations are most easily done with a computer, but they can, of course, be done manually. As an example, to find the decoupled Mx reading, using the raw analog voltages, multiply the Mx row (A4) by the analog channel readings in volts. This gives the decoupled output as a fraction of full scale (assumes 10V full scale).

(A4,1 X C1) + (A4,2 X C2) + (A4,3 X C3) . . . +(A4,6 X C6) = Mx

A brief Pascal procedure showing one possible way of programming a computer for the decoupling matrix multiplication is shown on the next page.

SAMPLE PASCAL CODE FOR DECOUPLING:

```
TYPE
        matrix = ARRAY[0..5,0..5] OF real;
        vector = ARRAY[0..5] OF real;

PROCEDURE mult (mat : matrix; vecIn : vector; VAR vecOut : vector);
VAR
  row : INTEGER;
  col : integer;

BEGIN
  FOR row := 0 TO 5 DO
    BEGIN
      vecOut [row] := 0;
      FOR col := 0 to 5 DO
        vecOut [row] := vecOut [row] + vecIn[col] * mat [row, col];
    END;
END;
```