

# iC-BM FOUR-CHANNEL FOUR-QUADRANT ANALOG MULTIPLIER



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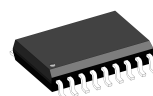
## FEATURES

MLT04 replacement  
 Four independent channels  
 Four-quadrant multiplication  
 Voltage output:  $W = 0.4 \times X \times Y$   
 $\pm 2.5$  V analog input range  
 3.5 MHz bandwidth  
 Low power dissipation

## APPLICATIONS

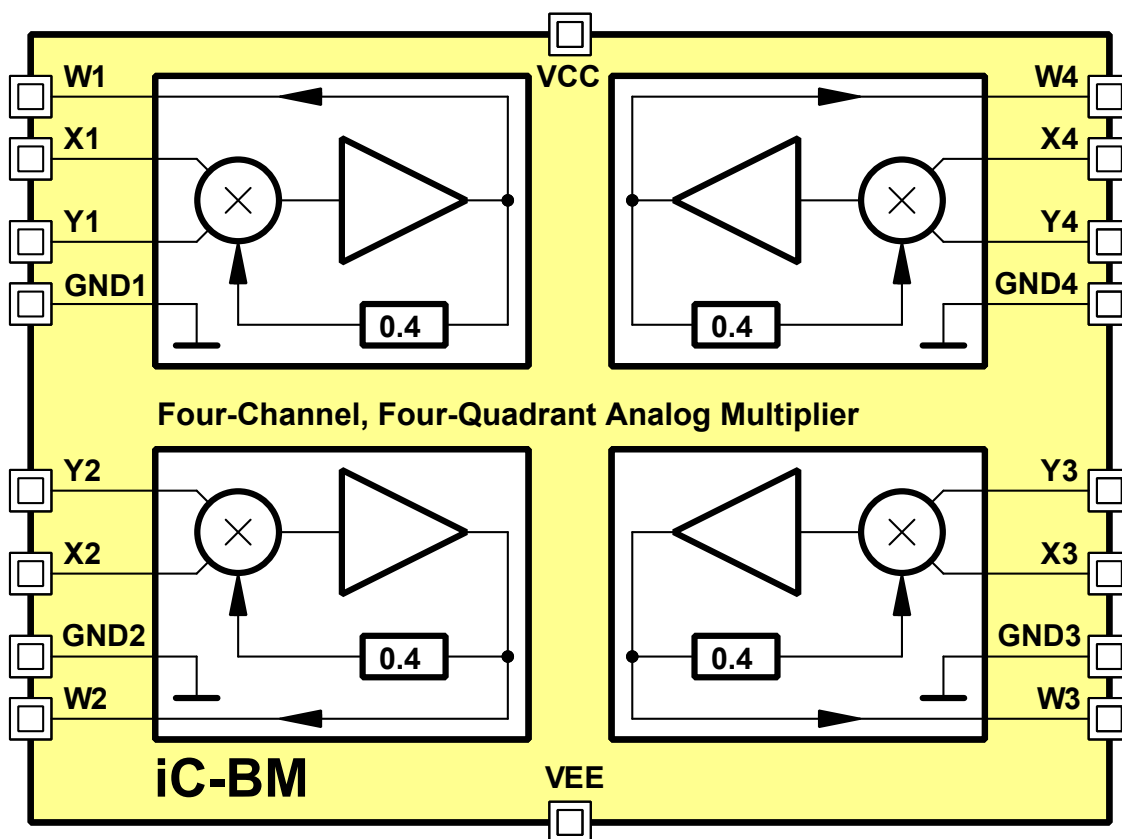
Analog computation  
 Squaring circuits  
 Modulation and demodulation  
 Voltage controlled amplifiers and filters

## PACKAGES



SO18W  
 (RoHS compliant)

## BLOCK DIAGRAM



# iC-BM FOUR-CHANNEL FOUR-QUADRANT ANALOG MULTIPLIER



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## DESCRIPTION

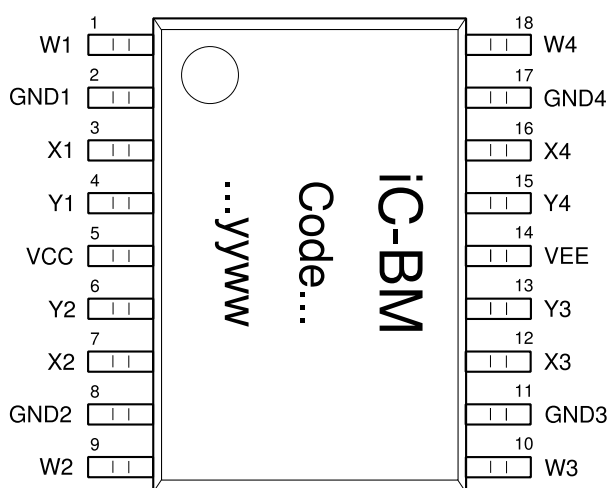
iC-BM features four analog multipliers. Each four-quadrant multiplier consists of a Gilbert cell multiplier with a 0.4 scale factor, a linearisation circuit and a unity gain output amplifier.

For higher precision all internal bias currents are derived from an internal band-gap reference.

All pins are ESD protected.

## PACKAGES

### PIN CONFIGURATION SO18W



### PIN FUNCTIONS

#### No. Name Function

|    |      |                                       |
|----|------|---------------------------------------|
| 1  | W1   | Channel 1: Analog multiplier output   |
| 2  | GND1 | Channel 1: Ground                     |
| 3  | X1   | Channel 1: First input of multiplier  |
| 4  | Y1   | Channel 1: Second input of multiplier |
| 5  | VCC  | Positive power supply +5 V            |
| 6  | Y2   | Channel 2: Second input of multiplier |
| 7  | X2   | Channel 2: First input of multiplier  |
| 8  | GND2 | Channel 2: Ground                     |
| 9  | W2   | Channel 2: Analog multiplier output   |
| 10 | W3   | Channel 3: Analog multiplier output   |
| 11 | GND3 | Channel 3: Ground                     |
| 12 | X3   | Channel 3: First input of multiplier  |
| 13 | Y3   | Channel 3: Second input of multiplier |
| 14 | VEE  | Negative power supply -5 V            |
| 15 | Y4   | Channel 4: Second input of multiplier |
| 16 | X4   | Channel 4: First input of multiplier  |
| 17 | GND4 | Channel 4: Ground                     |
| 18 | W4   | Channel 4: Analog multiplier output   |

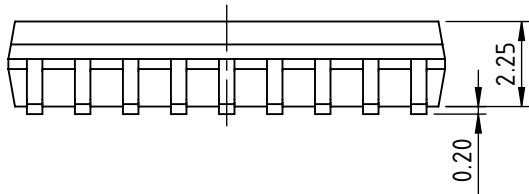
# iC-BM FOUR-CHANNEL FOUR-QUADRANT ANALOG MULTIPLIER



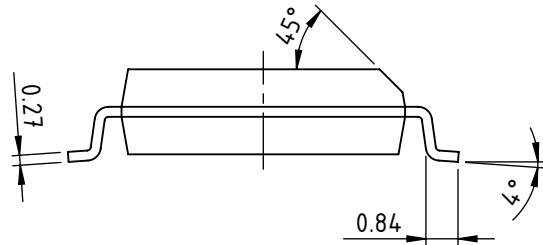
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## PACKAGE DIMENSIONS SO18W

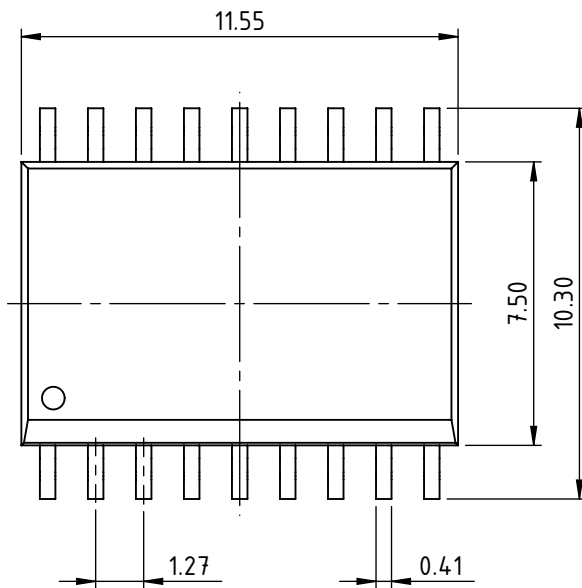
SIDE



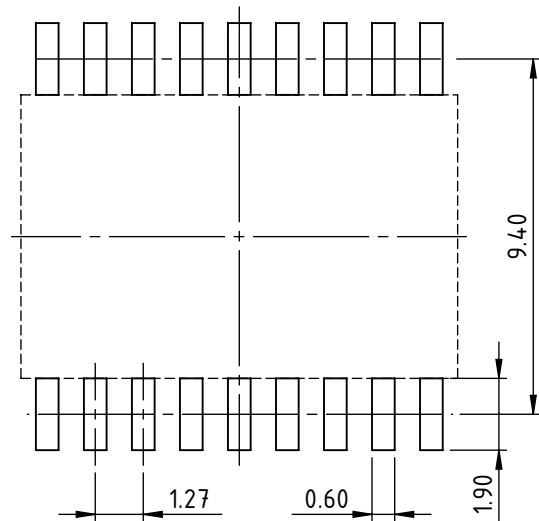
FRONT



TOP



RECOMMENDED PCB-FOOTPRINT



dra\_so18w-1\_pack\_1, 5:1

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## ABSOLUTE MAXIMUM RATINGS

Beyond these values damage may occur; device operation is not guaranteed.

| Item No. | Symbol         | Parameter  | Conditions |      |      | Unit |
|----------|----------------|--|------------|------|------|------|
|          |                |  |            | Min. | Max. |      |
| G001     | VCC            | Positive Power Supply  |            |      | 7    | V    |
| G002     | VEE            | Negative Power Supply  |            | -7   |      | V    |
| G003     | V()            | Voltage at Pins X <sub>1...4</sub> , Y <sub>1...4</sub> and W <sub>1...4</sub> |            | -7   | 7    | V    |
| G004     | T <sub>j</sub> | Chip Temperature   |            | -40  | 150  | °C   |
| G005     | T <sub>s</sub> | Storage Temperature  |            | -40  | 150  | °C   |

## THERMAL DATA

Operating Conditions: VCC = 5 V ±0.25 V, VEE = -5 V ±0.25 V, T<sub>j</sub> = -40...100 °C, R<sub>L</sub> = 2 kΩ, if not other specified

| Item No. | Symbol            | Parameter                           | Conditions |      |      |      | Unit |
|----------|-------------------|-------------------------------------|------------|------|------|------|------|
|          |                   |                                     |            | Min. | Typ. | Max. |      |
| T01      | T <sub>a</sub>    | Operating Ambient Temperature Range |            | -40  |      | 85   | °C   |
| T02      | R <sub>thja</sub> | Thermal Resistance Chip/Ambient     |            |      | 68   |      | K/W  |

All voltages are referenced to ground unless otherwise stated.

All currents flowing into the device pins are positive; all currents flowing out of the device pins are negative.

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## ELECTRICAL CHARACTERISTICS

Operating Conditions:  $V_{CC} = 5\text{ V} \pm 0.25\text{ V}$ ,  $V_{EE} = -5\text{ V} \pm 0.25\text{ V}$ ,  $T_j = -40\text{...}100\text{ }^\circ\text{C}$ ,  $R_L = 2\text{ k}\Omega$ , if not other specified

| Item No.  | Symbol              | Parameter                                    | Conditions   | Min.  | Typ.      | Max.  | Unit                           |
|---|---------------------|--|--|-------|-----------|-------|--------------------------------|
|   |                     |  |  |       |           |       |                                |
| <b>General</b>  |                     |  |  |       |           |       |                                |
| 101   | V(VCC)              | Positive Supply Voltage Range                |  | 4.75  | 5         | 5.25  | V                              |
| 102   | V(VEE)              | Negative Supply Voltage Range                |  | -5.25 | -5        | -4.75 | V                              |
| 103   | I(VCC)              | Positive Supply Current                      | $W_{1...4}$ without load resistors   |       | 15        | 20    | mA                             |
| 104   | I(VEE)              | Negative Supply Current                      | $W_{1...4}$ without load resistors   | -20   | -15       |       | mA                             |
| 105   | $P_{DISS}$          | Power Dissipation                            | $P_{DISS} = 5\text{ V} \times I_{CC} + 5\text{ V} \times I_{EE}$   |       | 150       | 200   | mW                             |
| <b>Multiplier Performance</b>                                 |                     |  |  |       |           |       |                                |
| 201   | $V(X_{1...4})_{os}$ | Offset Voltage $X_{1...4}$                   | $V(X_{1...4}) = 0\text{ V}$ , $V(Y_{1...4}) = \pm 2.5\text{ V}$  | -50   |           | 50    | mV                             |
| 202   | $V(Y_{1...4})_{os}$ | Offset Voltage $Y_{1...4}$                   | $V(Y_{1...4}) = 0\text{ V}$ , $V(X_{1...4}) = \pm 2.5\text{ V}$  | -50   |           | 50    | mV                             |
| 203   | $V(W_{1...4})_{os}$ | Output Offset Voltage $W_{1...4}$            | $V(X_{1...4}) = 0\text{ V}$ , $V(Y_{1...4}) = 0\text{ V}$  | -50   |           | 50    | mV                             |
| 204   | $TCV()_{os}$        | Output Offset Drift $W_{1...4}$              | $V(X_{1...4}) = 0\text{ V}$ , $V(Y_{1...4}) = 0\text{ V}$  |       | 50        |       | $\mu\text{V}/^\circ\text{C}$   |
| 205   | K                   | Fix Scale Factor                             | $V(X_{1...4}) = \pm 2.5\text{ V}$ , $V(Y_{1...4}) = \pm 2.5\text{ V}$  | 0.38  | 0.4       | 0.42  | 1/V                            |
| 206   | $TE(X_{1...4})$     | Total Error $X_{1...4}$                      | $-2.5\text{ V} \leq X \leq 2.5\text{ V}$ , $Y = 2.5\text{ V}$ , measured as % of the $\pm 2.5\text{ V}$ full scale | -5    | $\pm 2$   | 5     | %                              |
| 207   | $TE(Y_{1...4})$     | Total Error $Y_{1...4}$                      | $-2.5\text{ V} \leq Y \leq 2.5\text{ V}$ , $X = 2.5\text{ V}$ , measured as % of the $\pm 2.5\text{ V}$ full scale | -5    | $\pm 2$   | 5     | %                              |
| 208   | $TCE(X_{1...4})$    | Total Error Drift $X_{1...4}$                | $V(X_{1...4}) = -2.5\text{ V}$ , $V(Y_{1...4}) = 2.5\text{ V}$   |       | 0.005     |       | $\%/^\circ\text{C}$            |
| 209   | $TCE(Y_{1...4})$    | Total Error Drift $Y_{1...4}$                | $V(Y_{1...4}) = -2.5\text{ V}$ , $V(X_{1...4}) = 2.5\text{ V}$   |       | 0.005     |       | $\%/^\circ\text{C}$            |
| 210   | SE()                | Total Square Error $X_{1...4}$ , $Y_{1...4}$ | $V(X_1) = V(Y_1)$ , $V(X_2) = V(Y_2)$ , $V(X_3) = V(Y_3)$ and $V(X_4) = V(Y_4)$                                    |       | 5         |       | %                              |
| 211   | $LE(X_{1...4})$     | Linearity Error $X_{1...4}$                  | $-2.5\text{ V} \leq X \leq 2.5\text{ V}$ , $Y = 2.5\text{ V}$  | -1    | $\pm 0.2$ | 1     | %                              |
| 212   | $LE(Y_{1...4})$     | Linearity Error $Y_{1...4}$                  | $-2.5\text{ V} \leq Y \leq 2.5\text{ V}$ , $X = 2.5\text{ V}$  | -1    | $\pm 0.2$ | 1     | %                              |
| <b>Dynamic Performance</b>                                    |                     |  |  |       |           |       |                                |
| 301   | BW                  | Small Signal Bandwidth                       | $V(W_{1...4}) = 0.1\text{ V}_{rms}$  |       | 3.5       |       | MHz                            |
| 302   | SR                  | Slew Rate                                    | $V(W_{1...4}) = \pm 2.5\text{ V}$  |       | 30        |       | V/ $\mu\text{s}$               |
| 303   | $t_s$               | Settling Time                                | $V(W_{1...4}) = \Delta 2.5\text{ V}$ and 1% error band   |       | 1         |       | $\mu\text{s}$                  |
| 304   | $FT_{AC}$           | AC Feedthrough                               | $V(X_{1...4}) = 0\text{ V}$ , $V(Y_{1...4}) = 1\text{ V}_{rms}$ and $f = 1\text{ kHz}$                             |       | -65       |       | dB                             |
| 305   | $CT_{AC}$           | Crosstalk                                    | $V(X_{1...4}) = V(Y_{1...4}) = 1\text{ V}_{rms}$ , $f = 100\text{ kHz}$ , applied to adjacent channel              |       | -90       |       | dB                             |
| <b>Outputs: <math>W_{1...4}</math></b>                        |                     |  |  |       |           |       |                                |
| 401   | Isc()               | Short Circuit Current                        |  |       | $\pm 30$  |       | mA                             |
| 402   | $THD(X_{1...4})$    | Total Harmonic Distortion $X_{1...4}$        | $f = 1\text{ kHz}$ , $V(Y_{1...4}) = 2.5\text{ V}$   |       | 0.1       |       | %                              |
| 403   | $THD(Y_{1...4})$    | Total Harmonic Distortion $Y_{1...4}$        | $f = 1\text{ kHz}$ , $V(X_{1...4}) = 2.5\text{ V}$   |       | 0.02      |       | %                              |
| 404   | PSSR()              | Power Supply Sensitivity Ratio               | $V(X_{1...4}) = V(Y_{1...4}) = 0\text{ V}$ , $V_{CC} = \Delta 5\%$ or $V_{EE} = \Delta 5\%$                        |       |           | 10    | mV/V                           |
| 405   | $EN_A$              | Audio Band Noise                             | $BW = 10\text{ Hz to } 50\text{ kHz}$  |       | 70        |       | $\mu\text{V}_{rms}$            |
| 406   | $EN_W$              | Wide Band Noise                              | $BW = 1.9\text{ MHz}$  |       | 590       |       | $\mu\text{V}_{rms}$            |
| 407   | en                  | Spot Noise Voltage                           | Noise at $f = 1\text{ kHz}$  |       | 0.3       |       | $\mu\text{V}/\sqrt{\text{Hz}}$ |
| 408   | $V_{max}()$         | Voltage Swing                                | $V_{CC} = +5\text{ V}$ , $V_{EE} = -5\text{ V}$  | 3.0   | 3.3       |       | V                              |
| 409   | ROUT()              | Open Loop Output Resistance                  | $V_{CC} = +5\text{ V}$ , $V_{EE} = -5\text{ V}$ , $T = +25\text{ }^\circ\text{C}$                                  |       | 60        |       | $\Omega$                       |
| <b>Inputs: <math>X_{1...4}</math>, <math>Y_{1...4}</math></b> |                     |  |  |       |           |       |                                |
| 501   | $VR()_{in}$         | Analog Input Range                           | $V(GND_{1...4}) = 0\text{ V}$  | -2.5  |           | 2.5*  | V                              |
| 502   | $I()_{in}$          | Input Current                                | $V(X_{1...4}) = V(Y_{1...4}) = 0\text{ V}$   |       | 2.3       | 10    | $\mu\text{A}$                  |
| 503   | $R()_{in}$          | Input Resistance                             |  |       | 1         |       | M $\Omega$                     |
| 504   | $C()_{in}$          | Input Capacitance                            |  |       | 3         |       | pF                             |

\* For input voltages  $> 3\text{ V}$  the output is undefined.

# iC-BM FOUR-CHANNEL FOUR-QUADRANT ANALOG MULTIPLIER



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We understand suitable application of our published designs to be state-of-the-art technology which can no longer be classed as inventive under the stipulations of patent law. Our explicit application notes are to be treated only as mere examples of the many possible and extremely advantageous uses our products can be put to.

**iC-BM** FOUR-CHANNEL  
FOUR-QUADRANT ANALOG MULTIPLIER



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**ORDERING INFORMATION**

| Type  | Package | Order Designation |
|-------|---------|-------------------|
| iC-BM | SO18W   | iC-BM SO18W       |

For technical support, information about prices and terms of delivery please contact:

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