

### GENERAL DESCRIPTION

The M685 is a dual SAW, selectable frequency VCSO frequency source for low-jitter clock generation. An integrated SAW (surface acoustic wave) delay line implements the high-Q VCO (voltage controlled oscillator) function, which results in low output phase noise and very low jitter. The M685-01 is available in a range of center frequencies from 125 to 177 MHz. The M685-02 provides 500 to 708 MHz. Guaranteed minimum pull-range of  $\pm 120$  ppm meets GbE requirements. (It also fully satisfies  $\pm 50$  ppm minimum pull-range specification commonly required.) Industry-standard  $K_{vco}$  (VCO Gain) provides full replacement compatibility. The M685 is well suited for phase-locked loop implementations, clock and data recovery circuits, and other timing applications in telecom and optical fiber networking systems (e.g., OC-48).



### PIN ASSIGNMENT (5 x 7.5mm SMT)

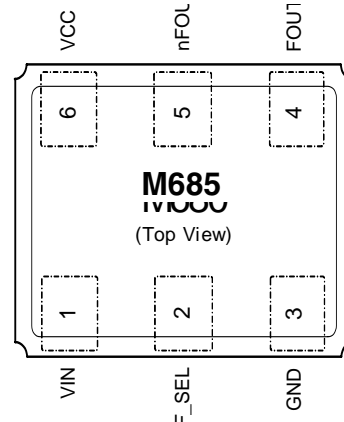


Figure 1: Pin Assignment

### FEATURES

- ◆ Two integrated SAW devices and selectable output frequency; supports multi-rate optical interfaces
- ◆ M685-01 output frequencies from 125 to 177 MHz  
M685-02 output frequencies from 500 to 708 MHz (Specify center frequencies at time of order)
- ◆ Industry-standard  $K_{vco}$  for full compatibility
- ◆ Low phase jitter 0.2ps rms typical for the M685-02 (50kHz to 80MHz)
- ◆ Differential 3.3V LVPECL output
- ◆ Single 3.3V power supply
- ◆ Small 5 x 7.5mm SMT (surface mount) package
- ◆ Pb-free / Compliant to EC RoHS Directive

### BLOCK DIAGRAM

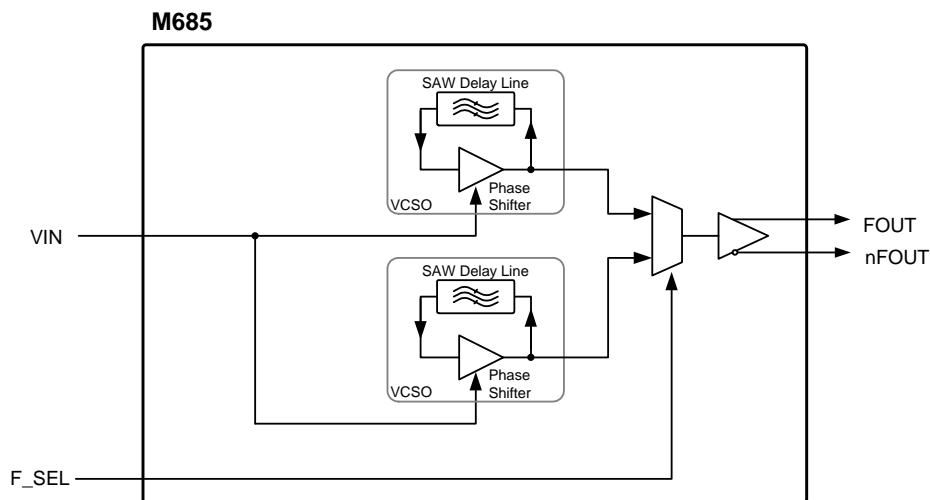


Figure 2: Block Diagram

### Sample of Available Output Frequencies

| VCSO Center Frequencies <sup>1</sup> (MHz) | Applications              |
|--|---------------------------|
| 155.5200, 167.3316                         | SONET/SDH, SONET/SDH FEC  |
| 156.2500, 161.1328                         | Gigabit Ethernet, GbE FEC |
| 622.0800, 669.3266                         | SONET/SDH, SONET/SDH FEC  |
| 625.0000, 644.5313                         | Gigabit Ethernet, GbE FEC |

Table 1: Sample of Available Output Frequencies

Note 1: Specify VCSO center frequencies at time of order

## PIN DESCRIPTIONS

| Number | Name  | I/O    | Configuration                            | Description   |
|--------|-------|--------|--|---|
| 1      | VIN   | Input  |  | Frequency control input.  |
| 2      | F_SEL | Input  | Internal pull-down resistor <sup>1</sup> | Frequency select:<br>Logic 1 selects Frequency 2.<br>Logic 0 selects Frequency 1. |
| 3      | GND   | Ground |  | Power supply ground connection.   |
| 4      | FOUT  | Output | No internal terminator                   | Clock output pair. Differential LVPECL.   |
| 5      | nFOUT |        |  |   |
| 6      | VCC   | Power  |  | Power supply connection, connect to +3.3V.  |

**Table 2: Pin Descriptions**

Note 1: See “Frequency Select” in Table 5 (DC Characteristics for M685-01 on pg. 3) and Table 7 (DC Characteristics for M685-02 on pg. 4).

## ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

| Symbol          | Parameter            | Rating                       | Unit |
|-----------------|----------------------|------------------------------|------|
| V <sub>I</sub>  | Inputs               | -0.5 to V <sub>CC</sub> +0.5 | V    |
| V <sub>O</sub>  | Outputs              | -0.5 to V <sub>CC</sub> +0.5 | V    |
| V <sub>CC</sub> | Power Supply Voltage | 4.6                          | V    |
| T <sub>S</sub>  | Storage Temperature  | -55 to +125                  | °C   |

**Table 3: Absolute Maximum Ratings**

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in Recommended Conditions of Operation, DC Characteristics, or AC Characteristics is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

## RECOMMENDED CONDITIONS OF OPERATION

| Symbol          | Parameter                     | Min  | Typ | Max  | Unit |
|-----------------|-------------------------------|------|-----|------|------|
| V <sub>CC</sub> | Positive Supply Voltage       | 2.97 | 3.3 | 3.63 | V    |
| T <sub>A</sub>  | Ambient Operating Temperature | -40  | 25  | +85  | °C   |

**Table 4: Recommended Conditions of Operation**

**ELECTRICAL SPECIFICATIONS FOR M685-01**
**DC Characteristics for M685-01**
*Unless stated otherwise,  $V_{CC} = 3.3 \text{ Volts} \pm 10\%$ ,  $T_A = 0 \text{ to } 85^\circ\text{C}$ , VCSO Freq.'s = 155.52, 167.3316MHz, Outputs terminated into  $180\Omega$  to ground*

|                               | Symbol         | Parameter                                | Pin         | Min             | Typ   | Max             | Unit          |
|-------------------------------|----------------|--|-------------|-----------------|-------|-----------------|---------------|
| Power Supply                  | $V_{CC}$       | Positive Supply Voltage                  | VCC         | 2.97            | 3.3   | 3.63            | V             |
|                               | $I_{CC}$       | Power Supply Current                     |             |                 | 90    | 125             | mA            |
| Control Voltage               | $V_{IN}$       | Input Control Voltage Range              | VIN         | 0               |       | 3.3             | V             |
|                               |                | $V_{IN}$ Input Impedence                 |             |                 | 100   |                 | k $\Omega$    |
| Frequency Select <sup>1</sup> | $V_{IH}$       | Input High Voltage                       |             | 2               |       | $V_{CC} + 0.3$  | V             |
|                               | $V_{IL}$       | Input Low Voltage                        |             | -0.3            |       | 0.8             | V             |
|                               | $I_{IH}$       | Input High Current                       | F_SEL       |                 |       | 5               | $\mu\text{A}$ |
|                               | $I_{IL}$       | Input Low Current                        |             | -150            |       |                 | $\mu\text{A}$ |
|                               | $R_{pulldown}$ | Internal Pull-down Resistor              |             |                 | 51    |                 | k $\Omega$    |
| Differential Outputs          | $V_{OH}$       | Output High Voltage                      |             | $V_{CC} - 0.98$ |       | $V_{CC} - 0.75$ | V             |
|                               | $V_{OL}$       | Output Low Voltage                       |             | $V_{CC} - 1.95$ |       | $V_{CC} - 1.63$ | V             |
|                               | $V_{P-P}$      | Peak to Peak Output Voltage <sup>2</sup> | FOUT, nFOUT | 0.450           | 0.625 | 0.85            | $V_{P-P}$     |
|                               | $I_{OUT}$      | Output Current                           |             |                 |       | 20              | mA            |

Note 1: Internally pulled down to Logic 0 (Frequency 1) if left unselected.

Note 2: Single-ended measurement. See Figure 3, Output Rise and Fall Time, on pg. 5.

**Table 5: DC Characteristics for M685-01**
**AC Characteristics for M685-01**
*Unless stated otherwise,  $V_{CC} = 3.3 \text{ Volts} \pm 10\%$ ,  $T_A = 0 \text{ to } 85^\circ\text{C}$ , VCSO Freq.'s = 155.52, 167.3316MHz, Outputs terminated into  $180\Omega$  to ground*

|                 | Symbol  | Parameter  | Min                   | Typ            | Max  | Unit    | Notes  |  |
|-----------------|---|--|-----------------------|----------------|------|---------|--|--|
| Control Voltage | $V_{IN}$                                      | Modulation Bandwidth                                   |                       | 600            |      | kHz     |  |  |
| Output          | $F_{OUT}$                                     | Output Center Frequency Range <b>M685-01</b>           | 125                   |                | 177  | MHz     |  |  |
|                 | APR   | Absolute (Guaranteed) Pull-Range <sup>1</sup>          | $\pm 120$             |                |      | ppm     |  |  |
|                 | $f_{STAB}$                                    | Frequency Stability                                    |                       | 100            |      | ppm p-p | At any given $V_{IN}$  |  |
|                 | $L_{IN}$                                      | Tuning Linearity                                       |                       | 6              |      | %       | $V_{IN} = 0.3 \text{ to } 3.0\text{V}$<br>Best fit straight line |  |
|                 | $K_{VCO}$                                     | VCO Gain   | @155.52MHz            |                | 400  |         | ppm/V  | $V_{IN} = 0.3 \text{ to } 3.0\text{V}$ |
|                 |   |  | Non-harmonic Spurious | -50            | -77  |         | dBc  |  |
|                 | $\Phi_n$                                      | SSB (single sideband) Phase Noise, offset from carrier | 100Hz Offset          |                | -48  |         | dBc/Hz   |  |
|                 |   |  | 1kHz Offset           |                | -75  |         | dBc/Hz   |  |
|                 |   |  | 10kHz Offset          |                | -99  |         | dBc/Hz   |  |
|                 |   |  | 100kHz Offset         |                | -124 |         | dBc/Hz   |  |
|                 |   |  | 1MHz Offset           |                | -142 |         | dBc/Hz   |  |
|                 | J(t)  | Jitter (rms)   | 12kHz to 20MHz        |                | 0.30 |         | ps rms   |  |
|                 |   |  | @155.52MHz            | 50kHz to 80MHz | 0.18 |         | ps rms   |  |
|                 | odc   | Output Duty Cycle <sup>2</sup>                         |                       | 45             |      | 55      | %  |  |
| $t_R$           | Output Rise Time <sup>2</sup> for FOUT, nFOUT |  |                       | 275            | 425  | ps      | 20% to 80%   |  |
| $t_F$           | Output Fall Time <sup>2</sup> for FOUT, nFOUT |  |                       | 275            | 425  | ps      | 20% to 80%   |  |

 Note 1: Also fully meets  $\pm 50$  ppm minimum pull-range specification that is commonly required.

Note 2: See Parameter Measurement Information on pg. 5.

**Table 6: AC Characteristics for M685-01**

**ELECTRICAL SPECIFICATIONS FOR M685-02**
**DC Characteristics for M685-02**
*Unless stated otherwise,  $V_{CC} = 3.3 \text{ Volts} \pm 10\%$ ,  $T_A = 0 \text{ to } 85^\circ\text{C}$ , VCISO Freq.'s = 622.08, 669.3266MHz, Outputs terminated into  $180\Omega$  to ground*

|                               | Symbol         | Parameter                                | Pin         | Min             | Typ   | Max             | Unit          |
|-------------------------------|----------------|--|-------------|-----------------|-------|-----------------|---------------|
| Power Supply                  | $V_{CC}$       | Positive Supply Voltage                  | VCC         | 2.97            | 3.3   | 3.63            | V             |
|                               | $I_{CC}$       | Power Supply Current                     |             |                 | 90    | 125             | mA            |
| Control Voltage               | $V_{IN}$       | Input Control Voltage Range              | VIN         | 0               |       | 3.3             | V             |
|                               |                | $V_{IN}$ Input Impedance                 |             |                 | 100   |                 | k $\Omega$    |
| Frequency Select <sup>1</sup> | $V_{IH}$       | Input High Voltage                       |             | 2               |       | $V_{CC} + 0.3$  | V             |
|                               | $V_{IL}$       | Input Low Voltage                        |             | -0.3            |       | 0.8             | V             |
|                               | $I_{IH}$       | Input High Current                       | F_SEL       |                 |       | 5               | $\mu\text{A}$ |
|                               | $I_{IL}$       | Input Low Current                        |             | -150            |       |                 | $\mu\text{A}$ |
|                               | $R_{pulldown}$ | Internal Pull-down Resistor              |             |                 | 51    |                 | k $\Omega$    |
| Differential Outputs          | $V_{OH}$       | Output High Voltage                      |             | $V_{CC} - 0.98$ |       | $V_{CC} - 0.75$ | V             |
|                               | $V_{OL}$       | Output Low Voltage                       |             | $V_{CC} - 1.95$ |       | $V_{CC} - 1.63$ | V             |
|                               | $V_{P-P}$      | Peak to Peak Output Voltage <sup>2</sup> | FOUT, nFOUT | 0.450           | 0.625 | 0.85            | $V_{P-P}$     |
|                               | $I_{OUT}$      | Output Current                           |             |                 |       | 20              | mA            |

Note 1: Internally pulled down to Logic 0 (Frequency 1) if left unselected.

Note 2: Single-ended measurement. See Figure 3, Output Rise and Fall Time, on pg. 5.

**Table 7: DC Characteristics for M685-02**
**AC Characteristics for M685-02**
*Unless stated otherwise,  $V_{CC} = 3.3 \text{ Volts} \pm 10\%$ ,  $T_A = 0 \text{ to } 85^\circ\text{C}$ , VCISO Freq.'s = 622.08, 669.3266MHz, Outputs terminated into  $180\Omega$  to ground*

|                 | Symbol  | Parameter   | Min                   | Typ | Max  | Unit    | Notes  |  |
|-----------------|---|---|-----------------------|-----|------|---------|--|--|
| Control Voltage | $V_{IN}$                                      | Modulation Bandwidth  |                       | 600 |      | kHz     |  |  |
| Output          | $F_{OUT}$                                     | Output Center Frequency Range <b>M685-02</b>                      | 500                   |     | 708  | MHz     |  |  |
|                 | APR   | Absolute (Guaranteed) Pull-Range <sup>1</sup>                     | $\pm 120$             |     |      | ppm     |  |  |
|                 | $f_{STAB}$                                    | Frequency Stability   |                       | 100 |      | ppm p-p | At any given $V_{IN}$  |  |
|                 | $L_{IN}$                                      | Tuning Linearity  |                       | 6   |      | %       | $V_{IN} = 0.3 \text{ to } 3.0\text{V}$<br>Best fit straight line |  |
|                 | $K_{VCO}$                                     | VCO Gain  | @622.08MHz            |     | 400  |         | ppm/V  | $V_{IN} = 0.3 \text{ to } 3.0\text{V}$ |
|                 |   |   | Non-harmonic Spurious | -50 | -77  |         | dBc  |  |
|                 | $\Phi_n$                                      | SSB (single sideband) Phase Noise, offset from carrier @622.08MHz | 100Hz Offset          |     | -42  |         | dBc/Hz   |  |
|                 |   |   | 1kHz Offset           |     | -72  |         | dBc/Hz   |  |
|                 |   |   | 10kHz Offset          |     | -102 |         | dBc/Hz   |  |
|                 |   |   | 100kHz Offset         |     | -127 |         | dBc/Hz   |  |
|                 |   |   | 1MHz Offset           |     | -146 |         | dBc/Hz   |  |
|                 | J(t)  | Jitter (rms) @622.08MHz   | 12kHz to 20MHz        |     | 0.22 |         | ps rms   |  |
|                 |   |   | 50kHz to 80MHz        |     | 0.16 |         | ps rms   |  |
| odc             | Output Duty Cycle <sup>2</sup>                |   | 45                    |     | 55   | %       |  |  |
| $t_R$           | Output Rise Time <sup>2</sup> for FOUT, nFOUT |   |                       | 275 | 400  | ps      | 20% to 80%   |  |
| $t_F$           | Output Fall Time <sup>2</sup> for FOUT, nFOUT |   |                       | 275 | 400  | ps      | 20% to 80%   |  |

 Note 1: Also fully meets  $\pm 50$  ppm minimum pull-range specification that is commonly required.

Note 2: See Parameter Measurement Information on pg. 5.

**Table 8: AC Characteristics for M685-02**

**PARAMETER MEASUREMENT INFORMATION**

**Output Rise and Fall Time**

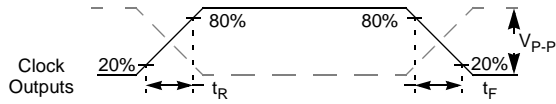


Figure 3: Output Rise and Fall Time

**Output Duty Cycle**

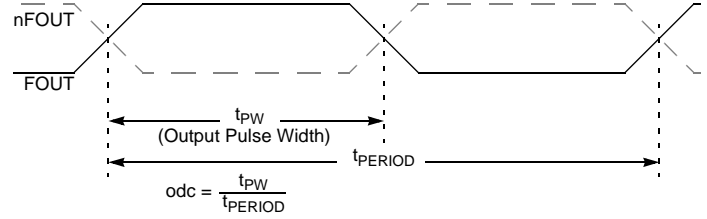
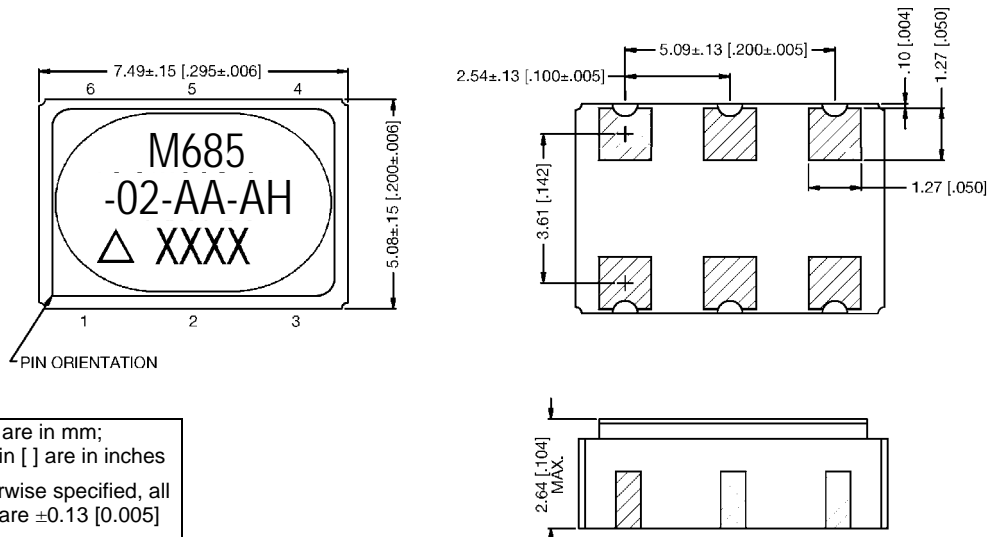


Figure 4: Output Duty Cycle

**DEVICE PACKAGE - 5 x 7.5mm SMT (Surface Mount) Package**

**Mechanical Dimensions:**



Dimensions are in mm;  
dimensions in [ ] are in inches  
Unless otherwise specified, all  
dimensions are ±0.13 [0.005]

Figure 5: Device Package - 5 x 7.5mm SMT (Surface Mount) Package

## ORDERING INFORMATION

### Part Numbering Scheme

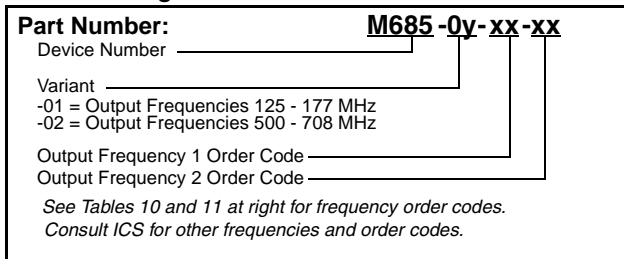


Figure 6: Part Numbering Scheme

### Example Order Numbers

| For Output Frequencies (MHz)<br>Frequency 1, Frequency 2 | Order Part Number<br>M685-0y-xx-xx |
|--|------------------------------------|
| 155.5200, 167.3316                                       | <b>M685-01-BA-BH</b>               |
| 156.2500, 161.1328                                       | <b>M685-01-BB-BD</b>               |
| 622.0800, 669.3266                                       | <b>M685-02-AA-AH</b>               |
| 625.0000, 644.5313                                       | <b>M685-02-AB-AD</b>               |

Table 9: Example Order Numbers

### M685-01 Standard Output Frequencies & Order Codes

|             |             |
|-------------|-------------|
| 125.0000 DA | 168.0407 BJ |
| 155.5200 BA | 172.6423 BK |
| 156.2500 BB | 173.3708 BL |
| 156.8324 BC | 164.3555 BM |
| 161.1328 BD | 153.6000 BO |
| 166.6286 BE | 118.7500 BP |
| 167.2820 BF | 176.8382 BQ |
| 167.3280 BG | 156.1762 BR |
| 167.3316 BH | 174.1537 BU |
| 167.7097 BI | 174.7031 BV |

Table 10: M685-01 Standard Output Frequencies & Order Codes

### M685-02 Standard Output Frequencies & Order Codes

|             |             |
|-------------|-------------|
| 500.0000 CA | 672.1627 AJ |
| 622.0800 AA | 690.5692 AK |
| 625.0000 AB | 693.4830 AL |
| 627.3296 AC | 657.4219 AM |
| 644.5313 AD | 614.4000 AO |
| 666.5143 AE | 475.0000 AP |
| 669.1281 AF | 707.3527 AQ |
| 669.3120 AG | 624.7048 AR |
| 669.3266 AH | 696.6149 AU |
| 670.8386 AI | 698.8123 AV |

Table 11: M685-02 Standard Output Frequencies & Order Codes

Consult IDT for the availability of other frequencies

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**PRODUCT APPLICATION CAUTION****F\_SEL Change During Power-Up Can Affect Output Frequency Accuracy**

M685E1

The M685 features an F\_SEL input which is used to select the internal VCSO frequency.

*The F\_SEL input logic level should not be changed while the M685 device is in operation (that is, voltage is applied to the pin VCC), particularly when the pin VIN (the control voltage input) is above 2.0V.*

Changing the F\_SEL input logic level during operation may result in an erroneous output frequency.

It is safe to change F\_SEL during operation if pin VIN can be held low, or at least below 2.0V.