



## 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 175 MHz. The M685-02 provides 500 to 700 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).

## FEATURES

- ◆ Two integrated SAW devices and selectable output frequency; supports multi-rate optical interfaces
- ◆ M685-01 output frequencies from 125 to 175 MHz  
M685-02 output frequencies from 500 to 700 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

## BLOCK DIAGRAM

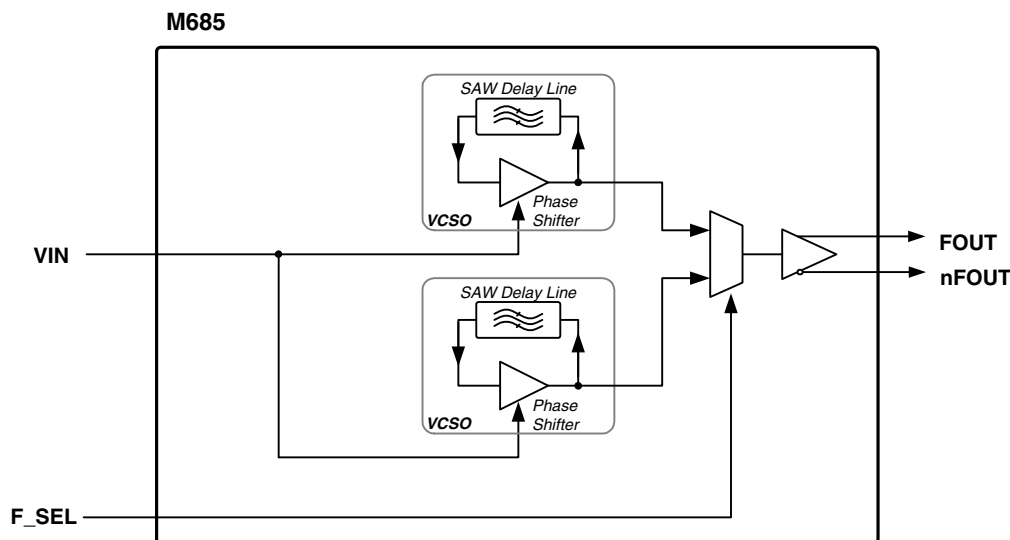


Figure 2: Block Diagram

## PIN ASSIGNMENT (5 x 7.5mm SMT)

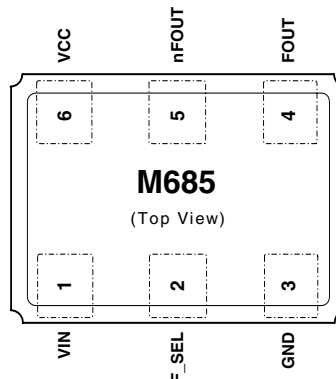


Figure 1: Pin Assignment

## 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: Logic 1 selects Frequency 2. 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 M685-01	125		175	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		%	$V_{IN} = 0.3 \text{ to } 3.0\text{V}$ 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,  $V_{CC} = 3.3 \text{ Volts} \pm 10\%$ ,  $T_A = 0 \text{ to } 85^\circ\text{C}$ , VCSO 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,  $V_{CC} = 3.3 \text{ Volts} \pm 10\%$ ,  $T_A = 0 \text{ to } 85^\circ\text{C}$ , VCSO 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 M685-02	500		700	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		%	$V_{IN} = 0.3 \text{ to } 3.0\text{V}$ 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**

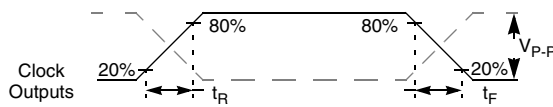


Figure 3: Output Rise and Fall Time

**Output Duty Cycle**

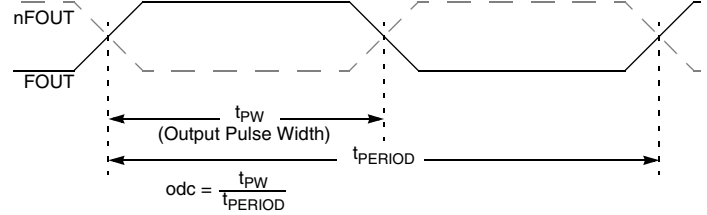
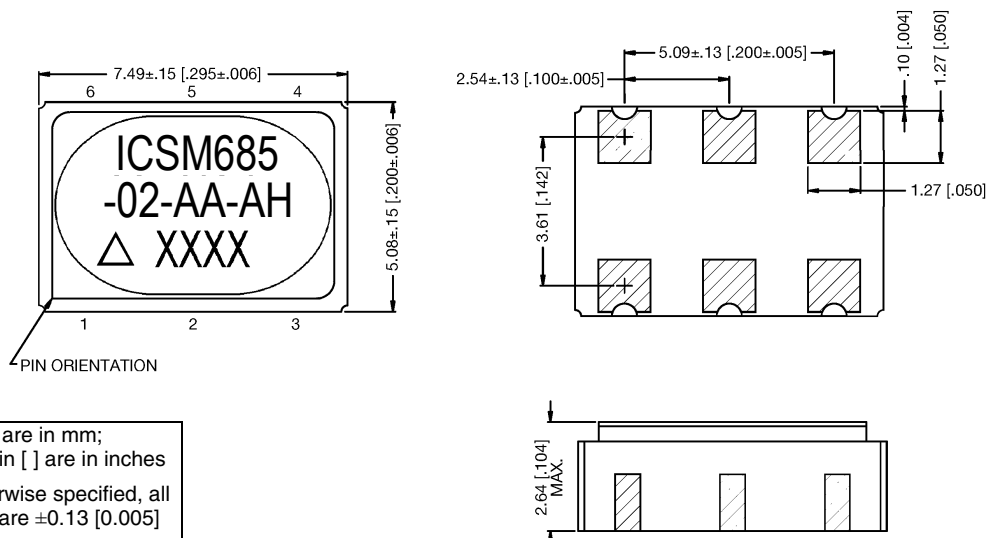


Figure 4: Output Duty Cycle

**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

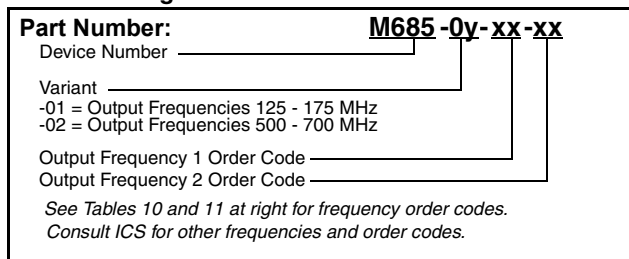


Figure 6: Part Numbering Scheme

### Example Order Numbers

For Output Frequencies (MHz) Frequency 1, Frequency 2	Order Part Number 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

153.6000 <b>BO</b>	167.2820 <b>BF</b>
155.5200 <b>BA</b>	167.3280 <b>BG</b>
156.2500 <b>BB</b>	167.3316 <b>BH</b>
156.8324 <b>BC</b>	167.7097 <b>BI</b>
161.1328 <b>BD</b>	168.0400 <b>BJ</b>
164.3555 <b>BM</b>	172.6423 <b>BK</b>
166.6286 <b>BE</b>	173.3708 <b>BL</b>

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

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

614.4000 <b>AO</b>	669.1281 <b>AF</b>
622.0800 <b>AA</b>	669.3120 <b>AG</b>
625.0000 <b>AB</b>	669.3266 <b>AH</b>
627.3296 <b>AC</b>	670.8386 <b>AI</b>
644.5313 <b>AD</b>	672.1600 <b>AJ</b>
657.4219 <b>AM</b>	690.5692 <b>AK</b>
666.5143 <b>AE</b>	693.4830 <b>AL</b>

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

*Consult ICS 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.