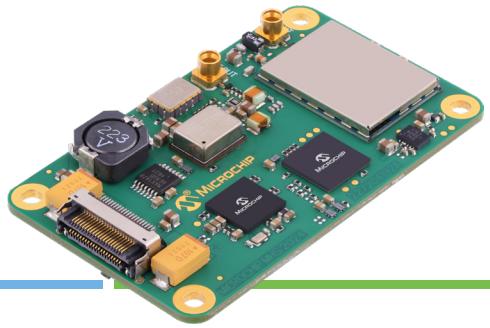
MD-300

MEMS-Based TCXO/OCXO Dual-Band GNSS Disciplined Oscillator Module



Summary

MD-300 modules are compact, MEMS-based TCXO or OCXO GNSS disciplined oscillators with a 2.5 × 1.5 footprint for board or chassis mounting. These modules feature an embedded dual-band multi-GNSS receiver (GPS, Galileo, BeiDou, NavIC L5) and include multiple outputs including 10 MHz sine wave (other frequencies available), differential RF and 1 PPS. They support an operating temperature of −40 °C to +85 °C.

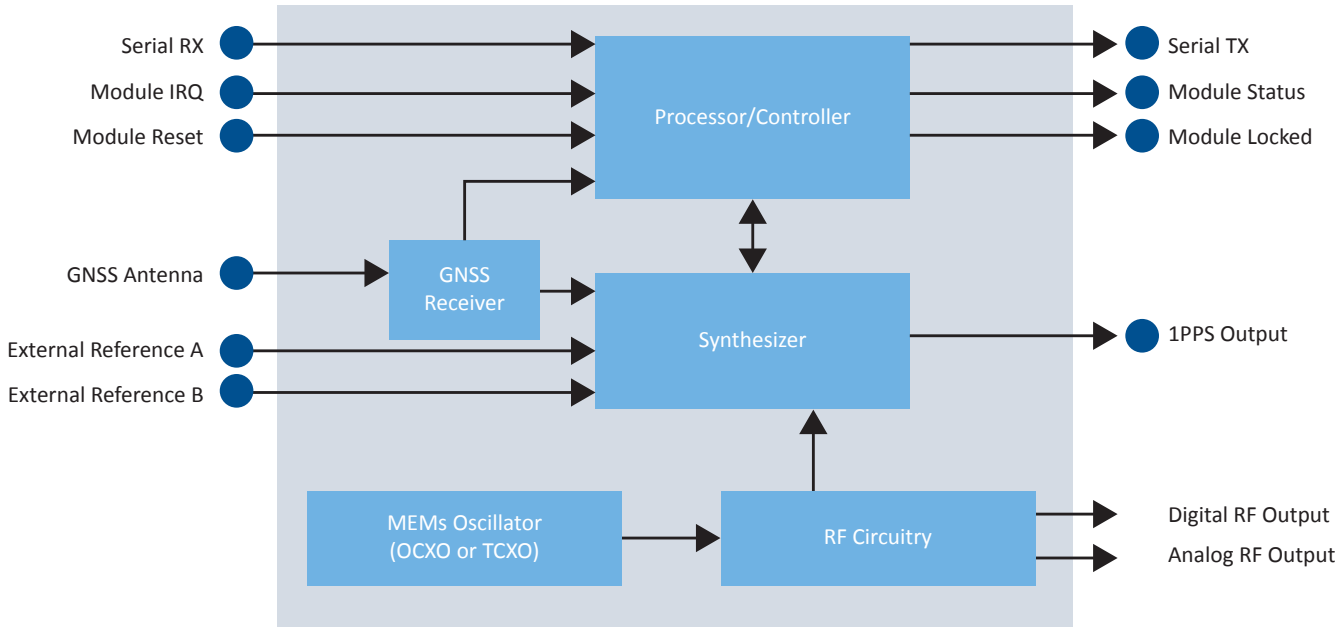
Features

- Internal MEMS-based OCXO or TCXO
- Embedded dual-band GNSS receiver
- Board-to-board or board-to-cable connector 0ptions
- Serial communications interface
- Two external reference inputs
- LVDS RF and 1 PPS outputs
- One 10 MHz sine wave output into 50Ω
- Other output frequencies available
- Ultra-low G-sensitivity
- Ultra-low thermal transient response

Applications

- Airborne
- Vehicle Platforms
- Radar Systems
- LTE and LTE Advanced (LTE-A)
- Laboratory Testing
- Base Stations
- MILSATCOM
- Navigation and Position Systems
- Radio Communications
- UAV/UAS
- Manufacturing Testing
- Time Syncronization

Functional Block Diagram



Summary Specifications

General Performance Characteristics						
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**	
Start-up Time			10	Seconds (s)	Time from power-off to availability of clock outputs; clock out specifications may not be met until lock is achieved	
Warm-up Time			7	Minutes (mins)	Time until clock specifications are met without any reference	
Time to Lock		1	10	mins	Time to phase lock after warmup completed; may vary based on reference quality, environmental stability and other factors	
+3.3V Analog Supply (VCCA)	3.2	3.3	3.4	Volts (V)		
+3.3V Analog Supply Ripple			50	mVpp		
+3.3V Digital Supply (VCCD)	3.2	3.3	3.4	V		
+3.3V Digital Supply Ripple			50	mVpp		
Total Power Consumption (VCCA, VCCD)		0.45	1.8 1.5	Watts (W)	OCXO Option TCXO Option	(Maximum value is warm-up)
Operating Temperature	-40		85	°C	Ambient	
Humidity	5		95	%	RH non-condensing, operational	
g-Sensitivity			0.1	ppb/g		

Absolute Maximum Ratings					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
+3.3V Analog Supply Voltage			3.47	VDC	
+3.3V Digital Supply Voltage			3.63	VDC	
Input Voltage on Any Single-Ended Digital I/O Pin	-0.5		5.5	V	
Input Voltage on Any LVDS I/O Pin	-0.3		3.9	V	
Input Voltage on Any UART Rx/Tx Pin	-8.0		13.0	V	
Output Load on Any Analog Outputs	10		150	Ohms (Ω) pF	
Output Load on Digital Outputs	10			Ω	
Antenna Input Power			13	dBm	
Storage Temperature	-40		125	°C	Ambient
Shock					MIL-STD-202H, Method 213, Condition F (1500g)

Vibration (Operating) **Vibration (Survival)**					MIL-STD-202H Method 214 Profile B at 15 min per axis 7.56 Grms MIL-STD-202H Method 214 Profile C at 15 min per axis 9.26 Grms
MTBF					3,726,700 hrs (ground benign) 730,270 hrs (airborne, inhabited cargo)

Local Oscillator (LO) Characteristics: TCXO Option					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Frequency		10		MHz	
Temperature Stability	-5		+5	PPB	Over entire operating range
Holdover (24 hr)		4.0		µs	Maximum time error of up to 7 hours in holdover after being on and locked for 30 days to an external 1 PPS The ambient temperature change shall be less than ±1°C during the holdover period with all other conditions constant
Aging[1]	−80 −0.2		+80 +0.2	PPB PPB	Yearly Daily
Control Loop Time Constant	1		5,000	s	
Phase Noise		−106 −126 −142 −145 −145 −160	−103 −121 −137 −143 −143 −157	dBc/Hz dBc/Hz dBc/Hz dBc/Hz dBc/Hz dBc/Hz	10 Hz offset 100 Hz offset 1 kHz offset 10 kHz offset 100 kHz offset 1 MHz offset
Stability (Allan Deviation)[3]		3E-11		10s tau	

Local Oscillator (LO) Characteristics: OCXO Option					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Frequency		10		MHz	
Temperature Stability	-1		+1	PPB	Over Entire Operating Range
Holdover (24 hr)		2.0		µs	Maximum time error of up to 8 hours in holdover after being on and locked for 30 days The ambient temperature change shall be less than ±1°C during the holdover period with all other conditions constant
Aging[1]	−30 −0.1		+30 +0.1	PPB PPB	Yearly Daily
Control Loop Time Constant	1		5,000	s	

Analog RF Output Characteristics[2]: OCXO Option					
Phase Noise		−110 −128 −140 −154 −164 −165		dBc/Hz dBc/Hz dBc/Hz dBc/Hz dBc/Hz dBc/Hz	10 Hz offset 100 Hz offset 1 kHz offset 10 kHz offset 100 kHz offset 1 MHz offset
Stability (Allan Deviation)[3]		5E-12 5E-12 5E-12		1s tau 10s tau 100s tau	

Common Analog RF Output Characteristics[2]				
Output Power	3	5	11	dBm
Output Impedance		50		Ω
Harmonics			-30	dBc
Spurious			-60	dBc

1. Aging performance is after 1 month (yearly) or 1 day (daily) of power-on. Temperature and aging rates are when device is not locked. Performance measured in still air.
2. Terminate unused output with 50Ω
3. Stability measured 2 hours after startup while in holdover/with no reference in constant temperature and still air. Stability may improve or degrade while locking based on reference and tuning quality.

1 PPS Output Characteristics (LVDS)					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Differential Voltage	250	350	450	mV	
Offset Voltage	1.125	1.220	1.375	V	
Rise/Fall Time	0.2	0.5	1.0	ns	
Pulse Width	10ns	100us	100ms		User configurable Positive polarity, rising edge
Programmable Delay	-2.0		+2.0	us	User configurable

RF Output Characteristics (LVDS)					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Differential Voltage	250	350	450	mV	
Offset Voltage	1.125	1.220	1.375	V	
Rise/Fall Time	0.2	0.5	1.0	ns	
Output Frequency		10		MHz	Nominal[1]

1. Standard output frequency is 10 MHz; other frequencies are available, contact factory for more information

Reference Input Characteristics (LVDS)[1]					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Differential High Threshold		-30	0	mV	
Differential Low Threshold	-100	-30		mV	
Common-Mode Voltage	0.10		2.35	V	
Input Termination		100		Ω	
Input Capacitance		6		pF	
Frequency	2 Hz	10 MHz	120 MHz		Clock Reference Mode[2]
Duty Cycle	45%	50%	55%		Clock Reference Mode
Pulse Width	1.0 µs	100 µs	100 ms		1 PPS Reference Mode
Input Rise Time			10	ns	1 PPS Reference Mode
Programmable Offset	-10.0	0	+10.0	ns	User-configurable input offset (cable delay)

1. These specifications apply to both reference input channels.
2. Reference may be a 1 PPS signal or a reference clock. Limitations exist on acceptable frequencies, see the Reference Input section of the device's user guide for more details. Frequencies must be divisible by integer 1, 2, 4, or 8 depending on frequency range.

Embedded GNSS Receiver Characteristics		
Parameter	**Value**	**Condition**
Type	Dual-Band Timing	L1/L2 or L1/L5 configurable
Frequency Bands	GPS L1C/A, L2C, L5	
	Galileo E1-B/C, E5b, E5a	
	BeiDou B1I, B1C, B2I, B2a	
	NavIC SPS-L5	
	QZSS L1C/A, L2C, L5	Available when GPS is used
	SBAS L1C/A	WAAS, EGNOS, MSAS, GAGAN disabled by default
Sensitivity	−167 dBm	Tracking (GPS + GLO + GAL + BDS)
	−148 dBm	Cold acquisition (GPS + GLO + GAL + BDS)
	−160 dBm	Reacquisition (GPS + GLO + GAL + BDS)
Position Accuracy	1.5m CEP	GPS only, static, −130 dBm, > 6 SVs
TTFF	29s	Cold start, GPS only
	2s	Hot start
Maximum Navigation Update Rate (User Configurable)	20 Hz	Single GNSS
	10 Hz	Multi GNSS
Max. Velocity	500 m/s	
Max. Altitude	80,000m	
Max. Dynamic Acceleration	4g	
Timing Accuracy	5 ns	1-sigma, fixed-position mode, cable delay compensated, ideal conditions

GNSS Antenna Input Characteristics					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Input Impedance		50		Ω	
Return Loss			9.5	dB	Over GPS L1 band frequency range
DC Output Voltage[1]	0		5.0	V	User controlled (on/off)
DC Output Current			100	mA	
DC Output Current Short-Circuit Detection Threshold	0	100	100	mA	User configurable
DC Output Current Open-Circuit Detection Threshold	0	10	100	mA	User configurable

1. DC output level depends on VCC_ANT input. An internal switch allows the module to switch DC power to the Antenna pin automatically (to prevent overcurrent) or manually based on user setting.

Single-Ended Output Characteristics[1,2]					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Drive Type					Open Drain
Output Voltage			VCCD	V	
Output Low Level Voltage (VOL)	0		0.5	V	IOL > −2.5 mA
Output Low Level Current (IOL)	-3.5			mA	
Output Fall Time		4		ns	10 pF load
External Pull-Up	1k	10k	100k	Ω	

Status Outputs		
STATUS/BIST	Active Low	Initially asserted upon successful completion of the Power-On Self-Test (POST) Cleared in the case of Built-In Self-Test (BIST) failure at any time
LOCKED	Active Low	Asserted when the LO is locked to the reference Locked status is determined by monitoring the control loop for lock quality

1. This includes the Status and Locked outputs.
2. These open-drain outputs require an external pull-up resistor.

nReset[1], nRecovery[2], and nIRQ[3] Inputs[4]					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Input Configuration					Active Low[5]
Internal Pull-Up Resistor		1.21k		Ω	
Input High Level Threshold (VIH)	2			V	
Input Low Level Threshold (VIL)			0.8	V	
Input Rise/Fall Rate			10	ns/V	

1. Asserting nReset will hold the module in reset until released.
2. Asserting and holding nRecovery prior to releasing nReset will force the module to start up in bootloader mode. It is only used for firmware recovery in the case that normal operation and/or firmware update procedures are unavailable. It is not recommended to use nRecovery as a standard firmware update entry method.
3. nIRQ can be configured for various modes including rising-edge trigger, falling-edge trigger, active high, or active low.
4. Leave unused input pins floating or tied to VCCD to ensure normal operation.
5. These inputs may be driven by an open-drain or push-pull driver. An internal pull-up resistor to VCCD is provided.

Communications Interface Serial UART Properties (RS-485)					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Differential Output Voltage	2.0			V	RL = 100 Ohm
Common Mode Output Voltage		VCCD/2	3	V	RL = 100 Ohm
Differential Input Threshold Voltage	-200	-120	-10	mV	
Input Capacitance		20		pF	
Output Protocols					VSIP1, NMEA-0183, VFMC2
Input Protocols					VSIP1, VFMC2
VSIP Version		2.1			See VSIP2.1 Reference Manual
NMEA-0183 Version		4.1			See our GNSSDO NMEA Reference Guide or documentation available from the NMEA or online
VSIP1 Reporting Interval	1	1	255	s	User configurable
NMEA Reporting Interval	1	1	255	s	Multiples of the GNSS receiver update rate3
Baud Rate	9,600	115,200	460,800	Baud	User selectable4
Configuration				8N1	(8 data bits, no parity, 1 stop bit)
Flow Control					None

1. VSIP = Proprietary NMEA-0183: Vectron® Serial Interface Protocol
2. VFMC = Proprietary NMEA-0183: Vectron's Firmware Update Protocol
3. The GNSS receiver can be configured for an update rate up to 20 Hz. NMEA is reported at an integer multiple of this rate. An updated rate of 1 Hz (default) results in a 1 to 255 second NMEA reporting interval.
4. Baud rate options: 9600, 19200, 38400, 57600, 115200, 230400, 460800

Lifetime					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Aging vs. Tune Range for All Oscillators	10			Years	Embedded oscillators must have enough trim range to compensate for aging as well as normal operating conditions for this duration of total cumulative lifetime operation.
Nonvolatile Memory Write Cycles	1,000,000			Cycles	The embedded nonvolatile memory used to store user configuration and nonvolatile state information must be rated to sustain this minimum number of write cycles per page (multiple settings may be stored in a single page).

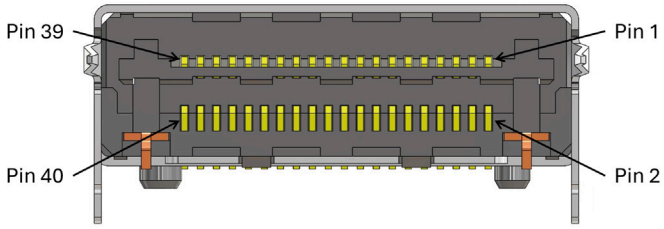
ESD[1,2]					
Parameter	**Min.**	**Typical**	**Max.**	**Units**	**Condition**
Human Body Model (HBM)	1,500			V	MIL-STD-833, Method 3015
Charged Device Model (CDM)	1,000			V	JEDEC, JESD22-C101

1. Although ESD protection circuitry has been designed into the module, proper precautions should be taken when handling and mounting.
2. Microchip employs a Human Body Model (HBM) and a Charged-Device Model (CDM) for ESD susceptibility testing and design protection.

Connectors		
Parameter	**Connector**	**Mating Connector[1]**
Top Right-Angle Connector	LSHM-120-01-L-DH-A-S	Board-to-Board Option: LSHM-120-01-L-RH-A-S Board-to-Cable Option: HLCD-20-06.00-TD-TH-1
Lower Board-to-Board Connector	TLH-020-0.50-G-D	SLH-010-1.50-G-D-A-K
Antenna Input	SMPM Plug, Male Pin, Full Detent	SMPM Jack, Female
RF Output	SMPM Plug, Male Pin, Full Detent	SMPM Jack, Female

1. Example mating connectors are provided for reference only. There may be additional mating connector options.

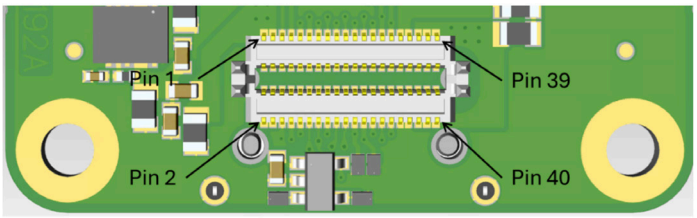
Connector Pinout: Top Right-Angle Connector



Pin #	Dir	Function
1	SUPPLY	VCCD
3	SUPPLY	VCCD
5	GND	GND
7	SUPPLY	VCC_BACKUP
9	DNC	RESERVED
11	DNC	RESERVED
13	IN	Ext. Reference Input A -
15	IN	Ext. Reference Input A +
17	IN	Ext. Reference Input B -
19	IN	Ext. Reference Input B+
21	OUT	RS485 Serial TX -
23	OUT	RS485 Serial TX +
25	DNC	RESERVED
27	In	Module Reset
29	OUT	Module Status
31	GND	GND
33	GND	GND
35	SUPPLY	VCCA
37	SUPPLY	VCCA
39	SUPPLY	VCCA

Pin #	Dir	Function
2	SUPPLY	ANT_VCC
4	SUPPLY	ANT_VCC
6	GND	GND
8	DNC	RESERVED
10	DNC	RESERVED
12	OUT	PPS Out -
14	OUT	PPS Out +
16		RESERVED
18	IN	RS485 Serial RX -
20	IN	RS485 Serial RX +
22	OUT	Module Locked
24	IN	Module IRQ
26	DNC	RESERVED
28	OUT	RF Out -
30	OUT	RF Out +
32	GND	GND
34	GND	GND
36	SUPPLY	VCCA
38	SUPPLY	VCCA
40	SUPPLY	VCCA
SHIELD	GND	GND

Connector Pinout: Bottom Board-to-Board Connector

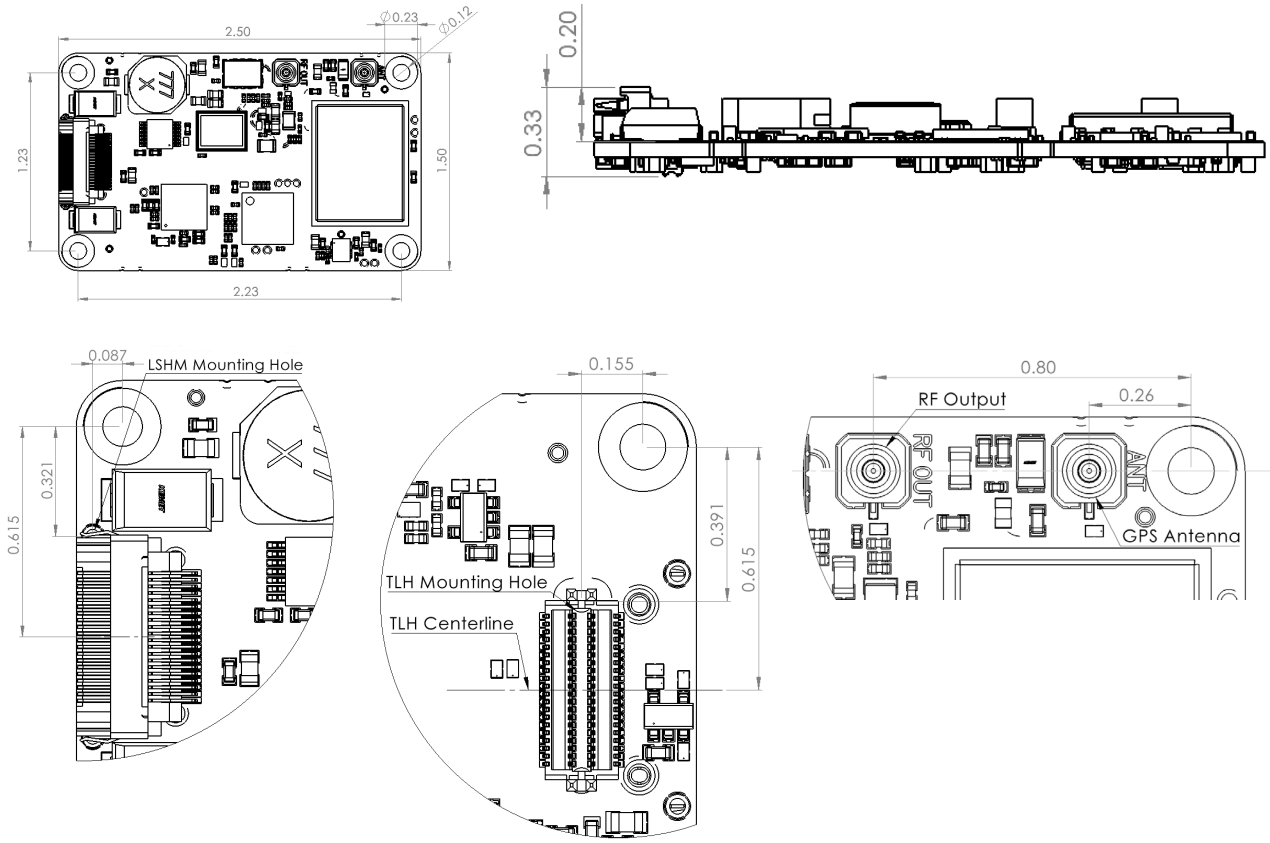


View from bottom of module PCB

Pin #	Dir	Function
1	SUPPLY	VCCD
3	SUPPLY	VCCD
5	GND	GND
7	SUPPLY	VCC_BACKUP
9	DNC	RESERVED
11	DNC	RESERVED
13	IN	Ext. Reference Input A -
15	IN	Ext. Reference Input A +
17	IN	Ext. Reference Input B -
19	IN	Ext. Reference Input B+
21	OUT	RS485 Serial TX -
23	OUT	RS485 Serial TX +
25	DNC	RESERVED
27	In	Module Reset
29	OUT	Module Status
31	GND	GND
33	GND	GND
35	SUPPLY	VCCA
37	SUPPLY	VCCA
39	SUPPLY	VCCA

Pin #	Dir	Function
2	SUPPLY	ANT_VCC
4	SUPPLY	ANT_VCC
6	GND	GND
8	DNC	RESERVED
10	DNC	RESERVED
12	OUT	PPS Out -
14	OUT	PPS Out +
16	DNC	RESERVED
18	IN	RS485 Serial RX -
20	IN	RS485 Serial RX +
22	OUT	Module Locked
24	IN	Module IRQ
26	DNC	RESERVED
28	OUT	RF Out -
30	OUT	RF Out +
32	GND	GND
34	GND	GND
36	SUPPLY	VCCA
38	SUPPLY	VCCA
40	SUPPLY	VCCA

Outline Drawings



Accessories

Microchip Part Number	Description
MD-3XX Eval Kit	Evaluation Kit for MD-3xx Modules (module must be ordered separately)

Ordering Notes

Customization to unique customer requirements is available and is common for this level of integration. Common customizations include alternate output frequencies, temperature ranges, differing values, and methods of holdover specification and holdover optimization in the frequency domain. The table below lists existing combinations available as of the date of publication of this data sheet. Please contact the factory for additional options.

Ordering Information

MD - 300 - Y D E - OCXO - 10M0000000

Product Family
MD-300: MEMS Modules

Frequency Stability
Y: ±1 PPB
W: ±5 PPB

GNSS Receiver
D: Dual-Band GNSS

Frequency

Local Oscillator Type
OCXO: MEMS OCXO
TCXO: MEMS TCXO

Temperature Range
E: -40°C to +85°C

Catalog Part Number	Description
MD-300-YDE-OCXO-10M000000	MD-300, OCXO MEMS, 10 MHz, Dual-Band GNSS
MD-300-WDE-TCXO-10M000000	MD-300, TCXO MEMS, 10 MHz, Dual-Band GNSS

Notice

This data sheet is intended to specify hardware- and interface-related specifications and requirements only. Functional details, such as operating modes, configuration and software-based features, are documented in the module's reference guide(s). Specific requirements regarding functionality may be available in an additional control document.

Technical Support

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