HSM18001 RF Synthesizer Programming and Integration Guide

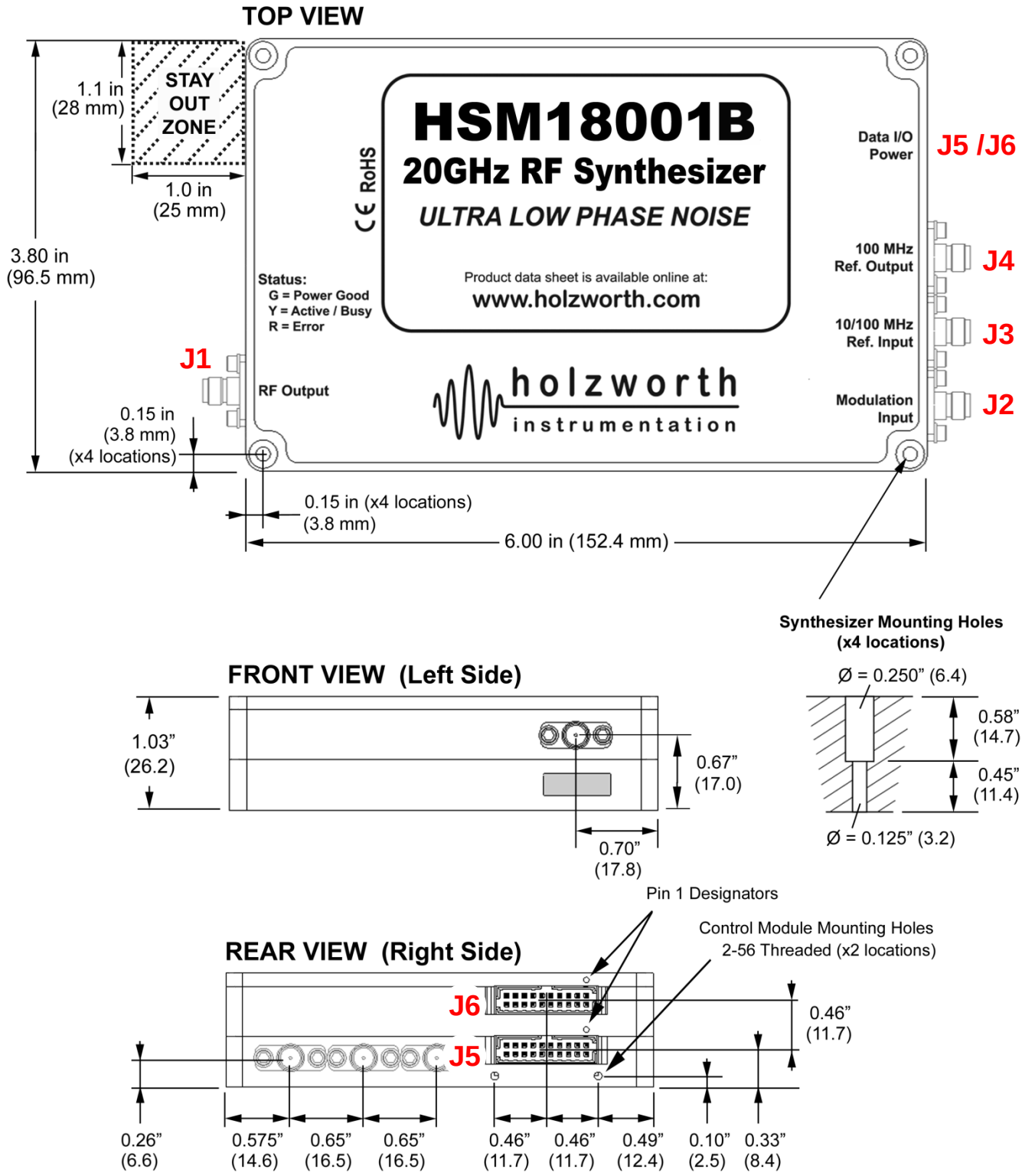
Revision 1.7
April, 2016

For Firmware Revision 4.14

MODELS COVERED:

HSM12001B
HSM18001B

HSM18001B Mechanical Configuration



HSM SERIES Module External Connections

HSM Base Front Panel:

LED Status	Green = Power Good, System Active
	Yellow = Communications Active / Busy / Not Ready
	Red = Error, i.e. PLL unlock, RF Pwr Unleveled, etc.

High Frequency Extension Front Panel:

RF Output	J1	Field replaceable stainless steel SMA

HSM Base Rear Panel:

REF In	J3	10MHz/100MHz Input, software selectable 10MHz: 0dBm to +10dBm Input Lock Range: ±1ppm (spec) +-4ppm (typ) 100MHz: 4dBm nominal, ±2dB Internal OCXO turned off
REF Out	J4	100MHz, +4dBm out (±2dbm)
HSM Power/Comm	J5	20pin, 2mm, 2x10 Molex Milli-grid shrouded pin header Contains Power, ground, spi and status indicators.

High Frequency Extension (HSE) Rear Panel:

Modulation Input	J2	Trigger input for external pulse modulation.
HSE Power/Comm	J6	20pin, 2mm, 2x10 Molex Milli-grid shrouded pin header Contains Power, ground, SPI and status indicators.

HSM Base Mechanical
20-pin Molex Connector (J5)

The Molex connector used is part of the 2mm Milli-Grid product line.

Module Connector Part Number:

Thru-Hole, Right Angle: Molex 87833-2020
Polarization and Ramp Locking

Mating Connector Part Numbers:

IDC Ribbon: Molex 87568-2093
Polarization and Ramp Locking
Vertical PCB Thru Hole: Molex 79107-7009
No Polarization or Ramp Locking
Vertical PCB SMT: Molex 79109-1009
No Polarization or Ramp Locking

Module Connector PINOUT:

PIN	Label	PIN	Label
1	GND	2	GND
3	+5V (1500mA Max)	4	+5V (1500mA Max)
5	+12V (600mA Max)	6	N.C. (reserved)
7	-5V/-12V (NA)	8	N.C. (reserved)
9	/RESET (10k PU)	10	N.C. (reserved)
11	/CS (Module Select – 47k PU)*	12	Trigger (5V Tolerant Input)
13	SDO (Module Data Output – 47k PD)	14	PowerGood (OC – 47k PU)
15	SDI (Module Data Input – 47k PD)	16	/ERROR (OC – 47k PU)
17	SCLK (Module Clock Input – 47k PD)	18	/BUSY (OC – 47k PU)
19	GND	20	GND

NOTES:
* Sub-system specific. Must be independently routed.
OC = Open Collector
PU = Pull-up, All Pull-ups to 3.3V

HSM Base PIN Descriptions:

+5V	Nominally pulls 1.2A from the +5V Rail. Initially at power on the draw will be 100mA then increase as subsystems power-on. Tolerance +8% to -1%. 4.95V to 5.4V. The value supplied to the module can be checked via software.
+12V	±5%. Nominally 300mA from this pin (T=25C). Increase to 550mA at startup for 5 mins as OCXO warms. +15V o.k. But increases power dissipation. The value supplied to the module can be checked via software.
-12V/-5V	Not needed on this revision.
/RESET	Active low on this pin puts the module in reset, releasing it returns to reset operation. Module is ready 2-3 seconds after /RESET is released. 10K pullup to 3.3V in parallel to 0.1uF cap to ground.
/CS	Communications chip select, active low. 47K pullup on this line. /CS must be low for any communication to occur. Must be routed independently. 3.3V logic levels, 5V tolerant.
MSDI	Master Serial Data Input (synthesizer module/slave data out). Active when chip select is low. High-Z when /CS is high. 47K pulldown. 3.3V logic levels, 5V tolerant.
MSDO	Master Serial Data Output (synthesizer module/slave data in). High-Z input on module. 3.3V logic levels, 5V tolerant. 47K pulldown.
SCLK	SPI Clock (slave clock input). Idle Low, Active High. Data is transitioned into the module on a rising low to high transition. Data is transitioned out on the same edge and is valid on the falling edge of SCLK. 3.3V logic levels, 5V tolerant. 47K pulldown.
TRIGGER	CMOS Trigger input to the onboard microprocessor. 47K pulldown.
PowerGood	Open collector output, 47k pullup to 3.3V. When high, power is healthy. When low, either voltages or currents are problematic. Module may not operate correctly. There is a 0.5 second delay from when power is applied to a valid PowerGood. Actual PowerGood may take up to 2 seconds to go high due to some very stable internal references that are settling. This may be multiplexed with other HSM series synthesizers.
/ERROR	Open collector output, 47k pullup to 3.3V. Nominally high. If an error condition occurs, such as a PLL unlock or un-leveled condition, this will go active low. This can be multiplexed with other HSM series synthesizers.
READY or /BUSY	Open collector output, 47k pullup to 3.3V. Nominally high. After an SPI communication, if a command has been issued, then the /BUSY will go active low until that command is finished. During this time no communication may occur and SPI bus will be asleep.
N.C.	These are reserved lines for use in our communications module. They should be left floating.

High Frequency Extension (HSE) Mechanical
20-pin Molex Connector (J6)

The Molex connector used is part of the 2mm Milli-Grid product line.

Module Connector Part Number:

Thru-Hole, Right Angle: Molex 87833-2020
Polarization and Ramp Locking

Mating Connector Part Numbers:

IDC Ribbon: Molex 87568-2093
Polarization and Ramp Locking
Vertical PCB Thru Hole: Molex 79107-7009
No Polarization or Ramp Locking
Vertical PCB SMT: Molex 79109-1009
No Polarization or Ramp Locking

Module Connector PINOUT:

PIN	Label	PIN	Label
1	GND	2	GND
3	+5V (2A Max)	4	+5V (2A Max)
5	+12V (700mA Max)	6	N.C. (reserved)
7	-12V (50mA Max)	8	N.C. (reserved)
9	/RESET (10k PU)	10	N.C. (reserved)
11	/CS (Module Select – 47k PU)*	12	Trigger (5V Tolerant Input)
13	SDO (Module Data Output – 47k PD)	14	PowerGood (OC – 47k PU)
15	SDI (Module Data Input – 47k PD)	16	/ERROR (OC – 47k PU)
17	SCLK (Module Clock Input – 47k PD)	18	/BUSY (OC – 47k PU)
19	GND	20	GND

NOTES:
*Sub-system specific. Must be independently routed.
OC = Open Collector
PU = Pull-up, All Pull-ups to 3.3V
PD = Pull-down, all Pull-downs to GND

PIN Descriptions:

+5V	Nominally pulls 1.5A from the +5V Rail. Initially at power on the draw will be 100mA then increase as subsystems power-on. Tolerance +8% to -1%. 4.95V to 5.4V. The value supplied to the module can be checked via software.
+12V	±5%. Nominally 500mA from this pin (T=25C). The value supplied to the module can be checked via software.
-12V	±5%. Nominally 30mA from this pin (T=25C).
/RESET	Active low on this pin puts the module in reset, releasing it returns to reset operation. Module is ready 2-3 seconds after /RESET is released. 10K pullup to 3.3V in parallel to 0.1uF cap to ground.
/CS	Communications chip select, active low. 47K pullup on this line. /CS must be low for any communication to occur. Must be routed independently. 3.3V logic levels, 5V tolerant.
MSDI	Master Serial Data Input (synthesizer module/slave data out). Active when chip select is low. High-Z when /CS is high. 47K pulldown. 3.3V logic levels, 5V tolerant.
MSDO	Master Serial Data Output (synthesizer module/slave data in). High-Z input on module. 3.3V logic levels, 5V tolerant. 47K pulldown.
SCLK	SPI Clock (slave clock input). Idle Low, Active High. Data is transitioned into the module on a rising low to high transition. Data is transitioned out on the same edge and is valid on the falling edge of SCLK. 3.3V logic levels, 5V tolerant. 47K pulldown.
TRIGGER	CMOS Trigger input to the onboard microprocessor. 47K pulldown.
PowerGood	Open collector output, 47k pullup to 3.3V. When high, power is healthy. When low, either voltages or currents are problematic. Module may not operate correctly. There is a 0.5 second delay from when power is applied to a valid PowerGood. Actual PowerGood may take up to 2 seconds to go high due to some very stable internal references that are settling. This may be multiplexed with other HSM series synthesizers.
/ERROR	Open collector output, 47k pullup to 3.3V. Nominally high. If an error condition occurs, such as a PLL unlock or un-leveled condition, this will go active low. This can be multiplexed with other HSM series synthesizers.
READY or /BUSY	Open collector output, 47k pullup to 3.3V. Nominally high. After an SPI communication, if a command has been issued, then the /BUSY will go active low until that command is finished. During this time no communication may occur and SPI bus will be asleep.
N.C.	These are reserved lines for use in our communications module. They should be left floating.

SPI Communication

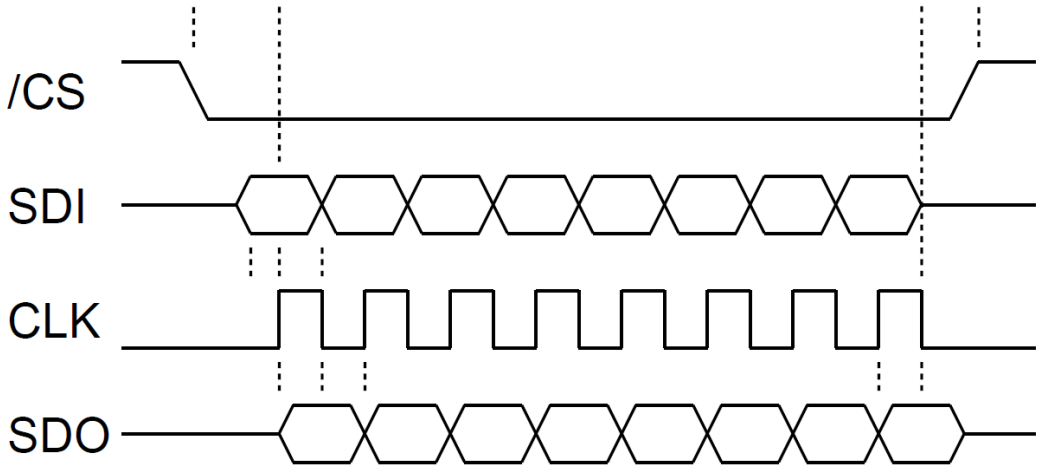
Bus Overview:

The SPI bus is a byte oriented bus, sending 8bits at a time. Any number of bytes may be sent, from 1 byte to 64 bytes while chip select is low. Bytes sent beyond 64 bytes will be ignored. The data is held in a buffer until chip select goes high, initiating the parsing of the data and execution of the commands. The maximum tested speed of the bus is 10Mbits/s. Data may be written to the module and data may be received from the module. After a command is sent requesting data, the next transfer sends this data out on SDO. During the read, a new command may be sent and will be parsed when chip select goes high. A read is always followed by a write with a read request.

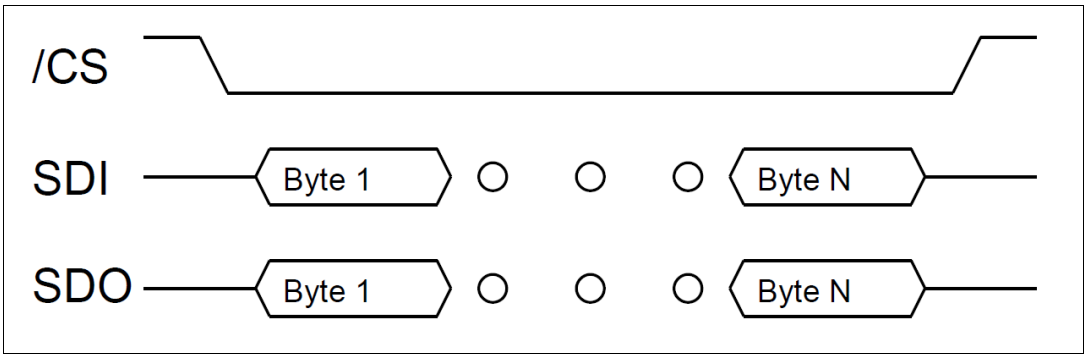
Bus Hardware Protocol:

Data is clocked into the module on the rising edge of sclk. Data is clocked out of the module on this same edge. Data output is valid on the falling edge of sclk. Data is only transferred when chip select is low. When chip select goes high, this initiates the parsing and execution of data.

SPI Timing



Bit level timing demonstrating where data is sampled into and out of the module on the rising edge of sclk. Data out is valid on the falling edge of sclk.



Binary Programming Commands

Four commands are supported in binary mode over the SPI bus. One command at any time may be issued between chip selects and the module responding with an active ready.

Command	Board	B1 Instruction (Hex)	B2 (MSB)	B3	B4	B5	B6	B7
Set Frequency (mHz)	BOTH	01h	Unsigned Integer - 48Bits					
Set Power (0.01dBm)	HSE	02h	Signed Integer					
Set Phase Offset (0.1deg)	HSM	03h	Unsigned Integer					

Always send MSB in the second byte. Position of LSB depends on the size of the integer.

Examples:

To set the RF frequency to 1.56GHz, send 01h to both boards in the first byte followed by the unsigned integer value of 1560000000000. MSB in the second byte and LSB in the seventh byte.

To set the RF power to 10.12dBm, send 02h to the HSE board in the first byte followed by the signed integer value of 1012. MSB in the second byte and LSB in the third byte.

To set the phase offset to 165.1 degrees, send 03h in the first byte followed by the unsigned integer value of 1651. MSB in the second byte and LSB in the third byte.

One command can be sent to change both the frequency and power level simultaneously. This command can be sent to both boards at the same time, and requires an extra two bytes be send over the SPI bus. As with the commands above, the first byte is the instruction byte. Bytes 2 through 7 are the same as the "Set Frequency" command above, bytes 8 and 9 are the same as the "Set Power" command.

Command	Board	B1 Instruction (Hex)	B2 (MSB)	B3	B4	B5	B6	B7	B8	B9
Set Frequency and Power	BOTH	0Ah	Unsigned Integer - 48Bits						Signed Integer	

SCPI Programming Command

SCPI commands are ASCII commands sent over the SPI bus. One command at a time may be issued between chip selects and the module responding with an active ready. The ASCII commands begin with a colon (:) or asterisk (*). There is read on a second SPI cycle with chip select low. Any number of characters may be read, or none at all. You do not need to read the RX.

If a command is not understood, the synthesizer will have in it's buffer:

Invalid Command

The format for describing the command instruction is as follows:

:COMMAND:<value>[suffix] A Description of the command here.

	<value>	Defined here, if any, queries typically have no value
	[suffix]	Units, i.e. Hz or dBm. If no suffix is included it is default to whatever is in brackets [Hz].
Example	TX:	Example ASCII sent in transmission
	RX:	Example ASCII received back, if a second transmission is made

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Capital Letters:

ASCII may be sent in upper or lower case or a mixture. All ASCII received is put to all capitals prior to parsing.

Decimal Places:

In general, any number of usable decimal places may be entered. For example, set frequency may have up to 12 decimal places if sent in GHz. A decimal does not have to be entered.

Preset / Save / Recall / Identify

***RST** Recall Factory Preset

Example TX: *RST

RX: Instrument Preset

This Command is accepted by the HSM module and the frequency extension module

***RCL** Recall Saved State

Example TX: *RCL

RX: State Recalled

This Command is accepted by the HSM module and the frequency extension module

***SAV** Save Current State

Example TX: *SAV

RX: State Saved

This Command is accepted by the HSM module and the frequency extension module

:IDN? Identify query

Example TX: :IDN?

RX: Holzworth,HSM18001A,M1009-041,Ver1.15,HSM18001-234

Format: Manufacturer, Device Name, Board Number, Firmware Version, Instrument Serial Number

This Command is accepted by the HSM module and the frequency extension module

To change frequency, the :FREQ: command must always be sent to both modules

Set Frequency

:FREQ:<value><suffix> Set Synthesizer RF Frequency

<value> Synthesizer Dependent
<suffix> Hz, kHz, MHz, GHz

Example TX: :FREQ:2.105GHz
RX: Frequency Set

This Command is accepted by the HSM module AND the frequency extension module

:FREQ? Query Synthesizer RF Frequency

Example TX: :FREQ?
RX: 22.67 MHz

This Command is accepted by the HSM module OR the frequency extension module

Set Phase Offset

:PHASE:<value> Set Synthesizer Phase Offset

<value> Degrees

Example TX: :PHASE:69

RX: Phase Set

This Command is accepted by the HSM module

:PHASE? Query Synthesizer Phase Offset

Example TX: :PHASE?

RX: 69.0

This Command is accepted by the HSM module

Set Power

:PWR:<value>[suffix] Set Synthesizer RF Power

<value> Synthesizer Dependent
[suffix] [dBm]

Example TX: :PWR:9.5dBm
RX: Power Set

This Command is accepted by the HSE module only.

:PWR? Query Synthesizer RF Power

Example TX: :PWR?
RX: 9.5

This Command is accepted by the HSE module only.

:PWR:MAX? Query Synthesizer Maximum RF Set Power

Example TX: :PWR:MAX?
RX: 23.00 dBm

This Command is accepted by the HSE module only.

:PWR:MIN? Query Synthesizer Minimum RF Set Power

Example TX: :PWR:MIN?
RX: -30.00 dBm

This Command is accepted by the HSE module only.

Set Reference EXT/INT

:REF:INT Set Synthesizer to internal reference only

Example TX: :REF:INT

RX: Reference Set to Internal

This Command is accepted by the HSM module

:REF:EXT:<value>[suffix] Set Synthesizer to an External Reference, specify frequency

<value> 10 or 100

[suffix] [MHZ]

Example TX: :REF:EXT:10MHZ

RX: Reference Set to External 10MHz

This Command is accepted by the HSM module

:REF? Query Synthesizer Reference Setting

Example TX: :REF?

RX: EXT:10MHz <or> EXT:100MHz <or> INT

This Command is accepted by the HSM module

:REF:PLL? Query Synthesizer PLL Lock Status. Only applies when using an external reference.

Example TX: :REF:PLL?

RX: PLL DISABLED <or> PLL UNLOCKED <or> PLL LOCKED

This Command is accepted by the HSM module

Set RF ON/OFF

:PWR:RF:<value> Set Synthesizer RF ON/OFF

	<value>	ON <or> OFF
Example	TX:	:PWR:RF:ON
	RX:	RF POWER ON

This Command is accepted by the HSM module only.

:PWR:RF? Query Synthesizer RF ON/OFF

Example	TX:	:PWR:RF?
	RX:	ON <or> OFF

This Command is accepted by the HSM module only.

To utilize modulation, the enable command must always be sent to both modules

Modulation Enable

:MOD:MODE:<value> Set Modulation Mode

<value> OFF <or> PULSE <or> PULSE:SRC:EXT <or> LOOKUP:WIDE <or> LOOKUP:NARROW

Example TX: :MOD:MODE:PULSE:SRC:EXT

RX: External Pulse Modulation Set

This Command is accepted by the HSM module AND the frequency extension module

:MOD:MODE? Query Modulation Mode Status

Example TX: :MOD:MODE?

RX: OFF <or> PULSE:EXT <or> LOOKUP:WIDE <or> LOOKUP:NARROW

This Command is accepted by the HSM module OR the frequency extension module

NOTE: Triggering is controlled differently depending on the modulation mode selected. PULSE MODULATION can ONLY be triggered using the modulation input SMA port on the back of the instrument. WIDE BAND LIST MODE can utilize software control with an HCM6 or HCM7 communication module or the SPI Trigger pins directly to initiate steps through the frequency list. NARROW BAND LIST MODE can operate in free running mode with an HCM6 or HCM7, and can also be used in free-running, trigger each point, and trigger list modes when using a custom SPI interface with access to the SPI Trigger pins (see pages 2-7 of this document).

Set Wide Band List Number of Points

:MOD:LIST:WIDE:PTS:<value> Set Wide Band List Number of Points

<value> Synthesizer Dependent

Example TX: :MOD:LIST:WIDE:PTS:500

RX: Wide Band Points Set

This Command is accepted by the HSM module AND the frequency extension module

:MOD:LIST:WIDE:PTS? Query Wide Band List Points

Example TX: :MOD:LIST:WIDE:PTS?

RX: 500

This Command is accepted by the HSM module OR the frequency extension module

:MOD:LIST:WIDE:PTS:MAX? Query Maximum Wide Band Points

Example TX: :MOD:LIST:WIDE:PTS:MAX?

RX: 3232

This Command is accepted by the HSM module OR the frequency extension module

NOTE: WIDE BAND LIST MODE can ONLY be used in free running mode when using an HCM6 or HCM7 communication module. When using a custom SPI communication interface with access to the SPI Trigger pins, each frequency step must be triggered using the Trigger pins (see pages 2-7 of this document). Free-running or trigger list functionality can be emulated by programming the trigger signal appropriately.

Set Wide Band List Values*

:MOD:LIST:WIDE:<point>,<freq><freq suffix>,<power>[power suffix],[dwell time][dwell suffix]		Set Wide Band List Value (for the given point)
	<point>	Point location. **NOTE:** Cannot be greater than the value set using :MOD:LIST:WIDE:PTS:
	<freq>	Synthesizer Dependent
	<freq suffix>	GHz, MHz, kHz, Hz
	<power>	Synthesizer Dependent
	[power suffix]	[dBm]
	[dwell time]	Synthesizer Dependent OPTIONAL **NOTE:** Dwell time only applies when using an HCM6 or HCM7
	[dwell suffix]	ms, [us] OPTIONAL
Example	TX:	:MOD:LIST:WIDE:1,100.1MHz,-1.0dBm,3.4ms
	RX:	Stored frequency, power, and dwell time for point 1 <or> Invalid point

:MOD:LIST:WIDE?<point>		Query Wide Band List Value (for the given point)
	<point>	Point location. **NOTE:** Cannot be greater than the value set using :MOD:LIST:WIDE:PTS:
Example	TX:	:MOD:LIST:WIDE?1
	RX:	1001.000 MHz,-1.00,3400 us <or> Invalid Point

***NOTE:** If a dwell time is not specified with each point, then the value used for dwell time will be the value set using the Set Wide Band Dwell Time command. The list of dwell times is not saved to the device. If the synthesizer is power cycled, then the complete list with dwell times must be reloaded. **These dwell times can only be utilized when using an HCM6 or HCM7 to communicate with the instrument.**

Set Wide Band Trigger

:MOD:MODE:LIST:WIDE:<value> Set Wide Band Trigger

	<value>	FREE or POINT
Example	TX:	:MOD:MODE:LIST:WIDE:FREE
	RX:	Wide Band Free Running Set

:MOD:MODE:LIST:WIDE? Query Wide Band Trigger

Example	TX:	:MOD:MODE:LIST:WIDE?
	RX:	WIDE LIST MODE TRIGGER FREE<or> WIDE LIST MODE TRIGGER POINT

:SET:TRIGGER:<value> Set Wide Band Trigger High or Low

	<value>	0 or 1
Example	TX:	:SET:TRIGGER:1
	RX:	TRIGGER set high

This command communicates with the HCM6 or HCM7 communication module only.

NOTE: WIDE BAND LIST MODE can only be operated in free-running mode when using an HCM6 or HCM7 to communicate with the instrument. Free-running or trigger point functionality can be utilized when using a custom SPI communication interface with access to the SPI Trigger pins on J5 and J6 (see pages 2-7 of this document).

Set Wide Band Dwell Time*

:MOD:LIST:WIDE:DWL:<value> Set Wide Band Dwell Time

	<value>	Synthesizer Dependent
	[suffix]	ms, [us]
Example	TX:	:MOD:LIST:WIDE:DWL:1ms
	RX:	Wide Band Dwell Time Set

:MOD:LIST:WIDE:DWL? Query Wide Band Dwell Time

Example	TX:	:MOD:LIST:WIDE:DWL?
	RX:	1000 us

:MOD:LIST:WIDE:DWL:MAX? Query Maximum Wide Band Dwell Time

Example	TX:	:MOD:LIST:WIDE:DWL:MAX?
	RX:	10000000 us

:MOD:LIST:WIDE:DWL:MIN? Query Minimum Wide Band Dwell Time

Example	TX:	:MOD:LIST:WIDE:DWL:MIN?
	RX:	100 us

*NOTE: If a dwell time is loaded with each point in Set Wide Band List Values, then the value for Set Wide Band Dwell Time will be ignored. **These dwell times can only be utilized when using an HCM6 or HCM7 to communicate with the instrument.**

Set Narrow Band List Number of Points

:MOD:LIST:NARROW:PTS:<value> Set Narrow Band List Number of Points

<value> Synthesizer Dependent

Example TX: :MOD:LIST:NARROW:PTS:300

RX: Narrow Band Points Set

This Command is accepted by the HSM module AND the frequency extension module

:MOD:LIST:NARROW:PTS? Query Narrow Band List Points

Example TX: :MOD:LIST:NARROW:PTS?

RX: 300

This Command is accepted by the HSM module AND the frequency extension module

:MOD:LIST:NARROW:PTS:MAX? Query Maximum Narrow Band Points

Example TX: :MOD:LIST:NARROW:PTS:MAX?

RX: 3232

This Command is accepted by the HSM module AND the frequency extension module

Set Narrow Band List Values*

:MOD:LIST:NARROW:<point>,<freq><freq suffix>,[dwell time][dwell suffix] — Set Narrow Band List Value (for the given point)

	<point>	Point location. Cannot be greater than the value set using :MOD:LIST:NARROW:PTS:
	<freq>	Synthesizer Dependent. All frequency values must be less than the first frequency point plus 5 percent.
	<freq suffix>	GHz,MHz, kHz, Hz
	[dwell time]	Synthesizer Dependent OPTIONAL
	[dwell suffix]	ms, [us] OPTIONAL
Example	TX:	:MOD:LIST:NARROW:2,996MHz,10us
	RX:	Stored frequency and dwell time for point 2 <or> Invalid point

This Command is accepted by the HSM module AND the frequency extension module

:MOD:LIST:NARROW?<point> — Query Narrow Band List Value (for the given point)

	<point>	Point location. Cannot be greater than the value set using :MOD:LIST:NARROW:PTS:
Example	TX:	:MOD:LIST:NARROW?2
	RX:	996.0000000 MHz,10us <or> Invalid point

This Command is accepted by the HSE module

*NOTE: If a dwell time is not specified with each point, then the value used for dwell time will be the value set using the Set Narrow Band Dwell Time command.

The list of dwell times is not saved to the device. If the synthesizer is power cycled, then the complete list with dwell times must be reloaded.

Set Narrow Band Trigger

:MOD:MODE:LIST:NARROW:<value> Set Narrow Band Trigger

	<value>	FREE or LIST or POINT
Example	TX:	:MOD:MODE:LIST:NARROW:FREE
	RX:	Narrow Band Free Running Set

This Command is accepted by the HSM module AND the frequency extension module

:MOD:MODE:LIST:NARROW? Query Narrow Band Trigger

Example	TX:	:MOD:MODE:LIST:NARROW?
	RX:	NARROW LIST MODE TRIGGER FREE <or> NARROW LIST MODE TRIGGER LIST <or> NARROW LIST MODE TRIGGER POINT

This Command is accepted by the HSM module

:SET:TRIGGER:<value> Set Narrow Band Trigger High or Low

	<value>	0 or 1
Example	TX:	:SET:TRIGGER:1
	RX:	TRIGGER set \high

This command communicates with the HCM6 or HCM7 communication module only.

NOTE: NARROW BAND LIST MODE can only be operated in free-running mode when using an HCM6 or HCM7 to communicate with the instrument. Free-running, trigger point, and trigger list functionality can be utilized when using a custom SPI communication interface with access to the SPI Trigger pins on J5 and J6 (see pages 2-7 of this document).

Set Narrow Band Dwell Time*

:MOD:LIST:NARROW:DWL:<value> Set Narrow Band Dwell Time

	<value>	Synthesizer Dependent
	[suffix]	ms, [us]
Example	TX:	:MOD:LIST:NARROW:700us
	RX:	Narrow Band Dwell Time Set

This Command is accepted by the HSM module AND the frequency extension module

:MOD:LIST:NARROW:DWL? Query Narrow Band Dwell Time

Example	TX:	:MOD:LIST:NARROW:DWL?
	RX:	700 us

This Command is accepted by the HSE module

:MOD:LIST:NARROW:DWL:MAX? Query Maximum Narrow Band Dwell Time

Example	TX:	:MOD:LIST:NARROW:DWL:MAX?
	RX:	10000000 us

:MOD:LIST:NARROW:DWL:MIN? Query Minimum Narrow Band Dwell Time

Example	TX:	:MOD:LIST:NARROW:DWL:MIN?
	RX:	6 us

This Command is accepted by the HSE module

*NOTE: If a dwell time is loaded with each point in Set Narrow Band List Values, then the value for Set Narrow Band Dwell Time will be ignored.

External Pulse Modulation

:MOD? Query Modulation Enable Status

Example TX: :MOD?

RX: OFF <or> PULSE:EXT

This Command is accepted by the HSE module only.

:MOD:MODE:PULSE:SRC:EXT Enable External Pulse Modulation

Example TX: :MOD:MODE:PULSE:SRC:EXT

RX: External Pulse Modulation Set

This Command is accepted by the HSE module only.

:MOD:MODE:OFF Disable External Pulse Modulation

Example TX: :MOD:MODE:OFF

RX: Mod Set Off

This Command is accepted by the HSE module only.

NOTE: When using EXTERNAL PULSE MODULATION, each pulse is triggered using the external modulation input SMA connector located on the back of the instrument (see pages 2-3 of this document).

Read Temperature

:TEMP? Query the temperature of the channel

Example TX: :TEMP?

RX: Temp = 40C

This Command is accepted by the HSM module

These commands communicate with the HCM7 or HCM6 communication modules only.

Communication Bus Information

:COMM:READY? Query if the communications bus is ready to receive a command.

Example TX: :COMM:READY?

RX: Communications Bus Ready <OR> Communications Bus is Busy

:COMM:VER? Query the communications bus firmware version

Example TX: :COMM:VER?

RX: Ver:1.7