HSM SERIES RF Synthesizer Programming and Integration Guide

Revision 3.25
January, 2013

For Firmware Revision 3.40

MODELS COVERED:

HSM SERIES MODULES
> HSM1001A
> HSM2001A
> HSM3001A
> HSM4001A
> HSM6001A

HSM SERIES Module External Connections

Front Panel:

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

Rear Panel:

REF In	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	100MHz, +4dBm out (+-2dbm)

Modulation	Modulation Input – Multiplexed, 50ohm Input
	  Frequency Modulation: +-1V Analog Input
	  Phase Modulation: +-1V Analog Input
	  Trigger/Pulse mod: 1.00V Threshold

Power/Comm	20pin, 2mm, 2x10 Molex Milli-grid shrouded pin header Contains Power, ground, spi and status indicators.

Mechanical
20-pin Molex Connector

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 (47k PU)	10	N.C. (reserved)
11	/CS (Module Select – 47k PU)	12	Trigger (5V Tolerant Input)
13	SDO (Module Data Output)	14	PowerGood (OC – 47k PU)
15	SDI (Module Data Input)	16	/ERROR (OC – 47k PU)
17	SCLK (Module Clock Input)	18	/BUSY (OC – 47k PU)
19	GND	20	GND

NOTES:

OC = Open Collector
PU = Pul-up, All Pull-ups to 3.3V

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. 47K pullup to 3.3V in parallel to 0.01uF cap to ground.
/CS	Communications chip select, active low. 47K pullup on this line. /CS must be low for any communication to occur. Allows for multiple synthesizer modules on 1 spi bus. 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. Not enabled at this time.
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.

Controlling Multiple Synthesizers:

The SPI bus may be daisy chained. The Status flags can be daisy chained as well, they are open-collector. Each synthesizer needs it's own chip select.

SPI Timing
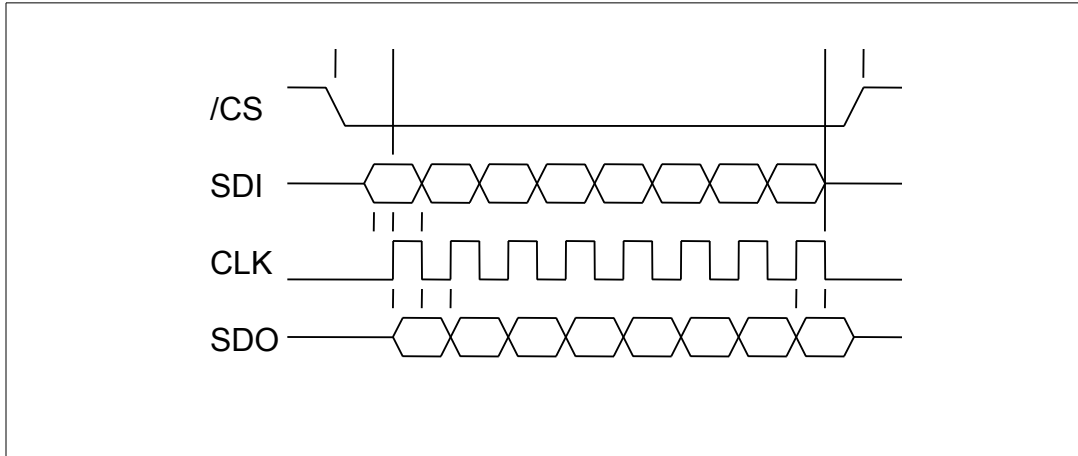
Bit level timing demonstrating where data is sampled into and out of the module on the rising edge of sclk. Data out is valid on the falling edge of sclk.
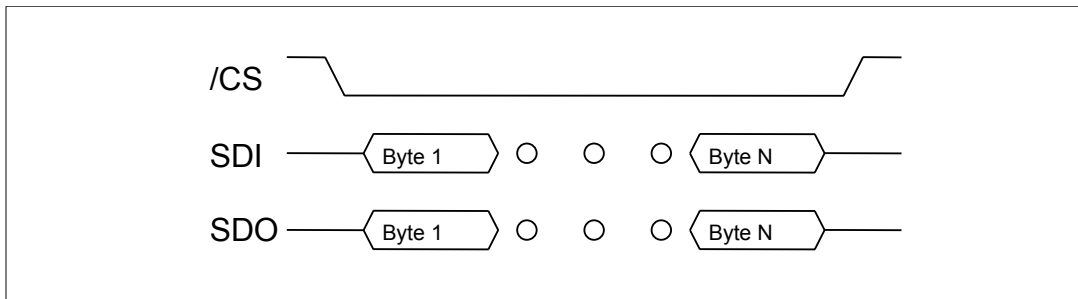
Byte level communications. Any number of bytes may be sent. After /CS goes high, the data is parsed and executed. If no data is sent, the SPI communications module simply resets itself and no parsing or execution of data occurs. If /CS goes high in the middle of a byte transfer (1-7 bits are sent instead of 8) this byte is ignored.

Binary Programming Commands

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

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

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SCPI Programming Commands

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

*RCL   Recall Saved State

      Example   TX: *RCL

                  RX: State Recalled

*SAV   Save Current State

      Example   TX: *SAV

                  RX: State Saved

:IDN?   Identify query

      Example   TX: :IDN?

                  RX: Holzworth,HSM6001A,M1009-041,Ver3.25,HSM6001-234

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

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

:FREQ?   Query Synthesizer RF Frequency

Example   TX: :FREQ?

RX: 22.67 MHz

:FREQ:MAX?   Query Synthesizer Maximum RF Set Frequency

Example   TX: :FREQ:MAX?

RX: 1.024 MHz

:FREQ:MIN?   Query Synthesizer Minimum RF Set Frequency

Example   TX: :FREQ:MIN?

RX: 0.25 MHz

Set Power

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

                                                                        <value>   Synthesizer Dependent

                                                                       [suffix]   [dBm]

       Example   TX: :PWR:9.5dBm

                        RX: Power Set

:PWR?   Query Synthesizer RF Power

       Example   TX: :PWR?

                        RX: 9.5

:PWR:MAX?   Query Synthesizer Maximum RF Set Power

       Example   TX: :PWR:MAX?

                        RX: 10.00 dBm

:PWR:MIN?   Query Synthesizer Minimum RF Set Power

       Example   TX: :PWR:MIN?

                        RX: -100.00 dbm

Set Phase

:PHASE:<value>[suffix]   Set Synthesizer RF Phase Offset

                    <value>   Synthesizer Dependent
                    [suffix]   [deg]

    Example   TX: :PHASE:270.1deg
                    RX: Phase Set

:PHASE?   Query Synthesizer RF Phase Offset

    Example   TX: :PHASE?
                    RX: 270.1

:PHASE:MAX?   Query Synthesizer Maximum RF Phase Offset

    Example   TX: :PHASE:MAX?
                    RX: 359.9deg

:PHASE:MIN?   Query Synthesizer Minimum RF Phase Offset

    Example   TX: :PHASE:MIN?
                    RX: 0.0deg

Set Reference EXT/INT

Setting or Reading the reference state does not apply to multichannel synthesizers

:REF:INT   Set Synthesizer to internal reference only

      Example   TX: :REF:INT

                   RX: Reference Set to Internal

: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

:REF?   Query Synthesizer Reference Setting

      Example   TX: :REF?

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

:REF:PLL?   Query Synthesizer PLL Lock Status. Only in use with an external reference.

      Example   TX: :REF:PLL?

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

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

:PWR:RF?   Query Synthesizer RF ON/OFF

   Example   TX: :PWR:RF?

               RX: ON <or> OFF

Modulation Enable

:MOD?   Query Modulation Enable Status

    Example   TX: :MOD?

                   RX: DIS <or> EXT

:MOD:MODE:<value>   Set Modulation Mode

                <value>   OFF <or> PULSE <or> PULSE:SRC:EXT <or> PULSE:SRC:INT <or> PULSE:SRC:INT:TRIGGER <or> FM <or> AM <or> PM <or> SWEEP:FREQ <or> LOOKUP:NARROW <or> LOOKUP:WIDE

    Example   TX: :MOD:MODE:PULSE

                   RX: Pulse Modulation Set

NOTE: In the value field above, PULSE or PULSE:SRC:EXT enable external pulse modulation.

:MOD:MODE?   Query Modulation Mode Status

    Example   TX: :MOD:MODE?

                   RX: OFF <or> PULSE:EXT <or> PULSE:INT <or> FM <or> AM <or> PM <or> SWEEP:FREQ <or> LOOKUP:NARROW <or> LOOKUP:WIDE

Set FM Deviation

:MOD:FM:DEV:<value>[suffix]   Set Synthesizer FM Deviation

<value>   Synthesizer Dependent

[suffix]   Hz, kHz

Example   TX: :MOD:FM:DEV:1.2kHz

RX: FM Deviation Set

:MOD:FM:DEV?   Query Synthesizer FM Deviation

Example   TX: :MOD:FM:DEV?

RX: 0.500 kHz

:MOD:FM:DEV:MAX?   Query Synthesizer Maximum FM Deviation

Example   TX: :MOD:FM:DEV:MAX?

RX: 100.000 kHz

Set AM Depth

:MOD:AM:DEPTH:<value>[suffix]   Set Synthesizer AM Depth

                    <value>   Synthesizer Dependent

               [suffix]   [percent]

     Example   TX: :MOD:AM:DEPTH:15 percent

                 RX: AM Depth Set

:MOD:AM:DEPTH?   Query Synthesizer AM Depth

     Example   TX: :MOD:AM:DEPTH?

                 RX: 60 percent

:MOD:AM:DEPTH:MAX?   Query Synthesizer Maximum AM Depth

     Example   TX: :MOD:AM:DEPTH:MAX?

                 RX: 75 percent

Set PM Deviation

:MOD:PM:DEV:<value>[suffix]   Set Synthesizer PM Deviation

<table>
<tr><td></td><td><value></td><td>Synthesizer Dependent</td></tr>
<tr><td></td><td>[suffix]</td><td>[deg]</td></tr>
<tr><td>Example</td><td>TX:</td><td>:MOD:PM:DEV: 45 deg</td></tr>
<tr><td></td><td>RX:</td><td>PM Deviation Set</td></tr>
</table>

:MOD:PM:DEV?   Query Synthesizer PM Deviation

<table>
<tr><td>Example</td><td>TX:</td><td>:MOD:PM:DEV?</td></tr>
<tr><td></td><td>RX:</td><td>10 deg</td></tr>
</table>

:MOD:PM:DEV:MAX?   Query Synthesizer Maximum PM Deviation

<table>
<tr><td>Example</td><td>TX:</td><td>:MOD:PM:DEV:MAX?</td></tr>
<tr><td></td><td>RX:</td><td>180 deg</td></tr>
</table>

Set Internal Pulse Rep Rate

:MOD:PULSE:REP:<value><suffix>   Set Internal Pulse Rep Rate

                    <value>   Synthesizer Dependent

                <suffix>   s, ms, [us]

    Example   TX: :MOD:PULSE:REP:45ms

                  RX: Pulse Rep Rate Set

:MOD:PULSE:REP?   Query Internal Pulse Rep Rate

    Example   TX: :MOD:PULSE:REP?

                  RX: 45000.0 us

:MOD:PULSE:REP:MAX?   Query Maximum Internal Pulse Rep Rate

    Example   TX: :MOD:PULSE:REP:MAX?

                  RX: 10000000.0 us

Set Internal Pulse Width

:MOD:PULSE:WIDTH:<value><suffix>   Set Internal Pulse Width

<div style="margin-left: 2em">

              <value>   Synthesizer Dependent

            <suffix>   s, ms, [us]

Example   TX: :MOD:PULSE:WIDTH:45ms

               RX: Pulse Width Set

</div>

:MOD:PULSE:WIDTH?   Query Internal Pulse Width

<div style="margin-left: 2em">

Example   TX: :MOD:PULSE:WIDTH?

               RX: 45000.0 us

</div>

:MOD:PULSE:WIDTH:MAX?   Query Maximum Internal Pulse Width

<div style="margin-left: 2em">

Example   TX: :MOD:PULSE:WIDTH:MAX?

               RX: 10000000.0 us

</div>

Set Number of Output Pulses

:MOD:PULSE:NUM:<value>   Set Number of Output Pulses for Internal Pulse
                                  Modulation

	<value>	Synthesizer Dependent
Example	TX:	:MOD:PULSE:NUM:10
	RX:	Number of Output Pulses Set

:MOD:PULSE:NUM?   Query Number of Output Pulses

Example	TX:	:MOD:PULSE:NUM?
	RX:	10

:MOD:PULSE:NUM:MAX?   Query Maximum Number of Output Pulses

Example	TX:	:MOD:PULSE:NUM:MAX?
	RX:	65535

The number of output pulses only applies when using Internal Pulse Modulation with a Trigger.

Set Frequency Sweep Start Frequency

:MOD:SWEEP:FREQ:START:<value><suffix>   Set Synthesizer Sweep Start RF Frequency

<value>   Synthesizer Dependent

<suffix>   Hz, kHz, MHz, GHz

Example   TX: :MOD:SWEEP:FREQ:START:100.1MHz

RX: Sweep Frequency Start Set

:MOD:SWEEP:FREQ:START?   Query Synthesizer Sweep Start RF Frequency

Example   TX: :MOD:SWEEP:FREQ:START?

RX: 100.1 MHz

The maximum and minimum for the Sweep Start Frequency are the same as the corresponding values for Set Frequency. Refer to the Set Frequency page for the maximum and minimum values.

Set Frequency Sweep Stop Frequency

:MOD:SWEEP:FREQ:STOP:<value><suffix>   Set Synthesizer Sweep Stop RF Frequency

<value>   Synthesizer Dependent

<suffix>   Hz, kHz, MHz, GHz

Example   TX: :MOD:SWEEP:FREQ:STOP:200.1MHz

RX: Sweep Frequency Stop Set

:MOD:SWEEP:FREQ:STOP?   Query Synthesizer Sweep Stop RF Frequency

Example   TX: :MOD:SWEEP:FREQ:STOP?

RX: 200.1 MHz

The maximum and minimum for the Sweep Stop Frequency are the same as the corresponding values for Set Frequency. Refer to the Set Frequency page for the maximum and minimum values.

Set Frequency Sweep Trigger

:MOD:SWEEP:FREQ:TRIG:<value>   Set Synthesizer Sweep Frequency Trigger

<value>   FREE or RAMP or POINT

Example   TX: :MOD:SWEEP:FREQ:TRIG:FREE

RX: Sweep Frequency Free Running Set

:MOD:SWEEP:FREQ:TRIG?   Query Synthesizer Sweep Frequency Trigger

Example   TX: :MOD:SWEEP:FREQ:TRIG?

RX: FREQ SWEEP TRIGGER FREE <or> FREQ SWEEP TRIGGER
RAMP <or> FREQ SWEEP TRIGGER POINT

Set Frequency Sweep Direction

:MOD:SWEEP:FREQ:DIR:<value>   Set Synthesizer Sweep Frequency Direction

              <value>   UP or DOWN

    Example   TX: :MOD:SWEEP:FREQ:DIR:UP

               RX: FREQ SWEEP DIRECTION UP

:MOD:SWEEP:FREQ:DIR?   Query Synthesizer Sweep Frequency Direction

    Example   TX: :MOD:SWEEP:FREQ:DIR?

               RX: FREQ SWEEP DIRECTION UP or FREQ SWEEP DIRECTION DOWN

Set Frequency Sweep Dwell Time

:MOD:SWEEP:FREQ:DWL:<value>   Set Synthesizer Sweep Dwell Time

<value>   Synthesizer Dependent

[suffix]   ms, [us]

Example   TX: :MOD:SWEEP:FREQ:DWL:1ms

RX: Sweep Frequency Dwell Time Set

:MOD:SWEEP:FREQ:DWL?   Query Synthesizer Sweep Dwell Time

Example   TX: :MOD:SWEEP:FREQ:DWL?

RX: 700 us

:MOD:SWEEP:FREQ:DWL:MAX?   Query Synthesizer Maximum Sweep Dwell Time

Example   TX: :MOD:SWEEP:FREQ:DWL:MAX?

RX: 10000000 us

:MOD:SWEEP:FREQ:DWL:MIN?   Query Synthesizer Minimum Sweep Dwell Time

Example   TX: :MOD:SWEEP:FREQ:DWL:MIN?

RX: 100 us

Set Frequency Sweep Number of Points

:MOD:SWEEP:FREQ:PTS:<value>   Set Synthesizer Sweep Number of Points

                <value>   Synthesizer Dependent

     Example   TX: :MOD:SWEEP:FREQ:PTS:50

                 RX: Sweep Frequency Points Set

:MOD:SWEEP:FREQ:PTS?   Query Synthesizer Sweep Points

     Example   TX: :MOD:SWEEP:FREQ:PTS?

                 RX: 50

:MOD:SWEEP:FREQ:PTS:MAX?   Query Synthesizer Maximum Sweep Points

     Example   TX: :MOD:SWEEP:FREQ:PTS:MAX?

                 RX: 65535

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

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

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

              RX: 500

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

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

              RX: 3232

*Minimum number of points is 2.

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. 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
[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. 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.

Set Wide Band Trigger

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

                <value>   FREE or LIST 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 LIST <or> WIDE LIST MODE TRIGGER POINT

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: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 the Set Wide Band List Values, then the value for Set Wide Band Dwell Time will be ignored.

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:NARROWPTS:300

                    RX: Narrow Band Points Set

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

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

                    RX: 300

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

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

                    RX: 3232

*Minimum number of points is 2.

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

: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,10 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 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

: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

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

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

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

: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

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

Read Temperature

:TEMP?   Query the temperature of the channel

    Example   TX: :TEMP?

                       RX: Temp = 40C