NOVATECH

NOVATECH INSTRUMENTS, INC.
Model DDS5m 40 MHz Lockable Synthesizer Module

INSTRUCTION MANUAL

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1.0 DESCRIPTION

1.1 The DDS5m is a Direct Digital Synthesizer module with RS232 serial or rotary switch control. It can source up to 40MHz sine and ACMOS/TTL square waves simultaneously in 0.025 Hz exact steps. Multiple units can be synchronized using an external standard and frequency update pulse. The last saved settings are stored in non-volatile memory.

1.2 The DDS5m module is contained on a 4.5 inch by 5.5 inch (11.4 cm by 14.0 cm) circuit board. SMB connectors are provided for Sine out, ACMOS out and External Standard in. Power of +5 and -5 VDC is required on a 5-pin connector header (mates with AMP # 640441-5 or equivalent). A two pin header is provided for External Update input. The RS232 connection is via a female DE-9 connector allowing direct connection to a PC serial port using readily available 9-pin monitor extension cables.

1.3 A jumper selection enables the DDS5m to operate from the internal clock only or to phase lock the internal clock to an External Standard. When locked to a Standard, the DDS5m accuracy and stability is equal to the External Standard.

2.0 SPECIFICATIONS

2.1 OUTPUT

Types: Simultaneous Sine and ACMOS (TTL compatible)
Impedance: 50 Ω
Range: 100 Hz to 40.000 MHz in 0.025 Hz steps

2.2 OUTPUT AMPLITUDE

Sine: Approx. 1 Vrms into open circuit, 0.5 Vrms into 50 Ω
ACMOS: (TTL Compatible) V_{OL}: 0.5 V max, V_{OH}: 3.5 V min into 30 pF, <5 ns rise and fall times

2.3 FREQUENCY CONTROL

Manual: Rotary switches allow setting in 0.1 Hz steps up to 40.000 MHz.
Serial: RS232 interface allows setting of frequency to 0.025 Hz. Fixed at 9600 baud. Internal (default) or external frequency update input can be used to synchronize frequency change.

2.4 PHASE CONTROL

Serial interface allows setting phase in 11.25 degree increments. An unlimited number of DDS5m can be phase synchronized together using an externally supplied CMOS level sync pulse. (When used with 1 MHz external standard.)

2.5 SPECTRAL PURITY (Typical)

Phase Noise: <-130 dBc @ 1 kHz offset @ 10 MHz out
Spurious: <-55 dBc below 10 MHz
<-45 dBc below 40 MHz
Harmonic: <-55 dBc below 10 MHz
<-40 dBc below 40 MHz

2.6 ACCURACY AND STABILITY (Internal Clock)

Accurate to < ± 5 ppm @ 23 C ± 5 C, 24 hrs
Stable to ± 10 ppm per year at 23 C ± 5 C

2.7 EXTERNAL STANDARD

The DDS5m will lock to and track an External Standard of 1, 2, 5 or 10 MHz to ± 2 ppm minimum. The locked accuracy and stability is dependent upon the accuracy and stability of the External Standard. Jumper selectable. 50 Ω input impedance. The External Standard can be 0.5 to 3 Vrms, sine or square wave.

2.8 CONNECTIONS

SMB for ACMOS out, Sine out and External Standard input. Five pin Molex # 22-23-2051 for power. DE9F for RS232.

2.9 POWER

+5 Vdc ± 0.1 V @ <350 mA
-5 Vdc ± 0.1 V @ <50 mA
< 50 mV noise and ripple

2.10 ENVIRONMENTAL

Operating Temperature: 5 C to 40 C
Humidity: 80% to 31 C, decreasing linearly to 50% at 40 C

2.11 SIZE

4.5 in by 5.5 in (11.4 cm by 14 cm)

3.0 INSTALLATION

NOTE

The DDS5m contains static sensitive components. Please observe static and ESD precautions when handling and installing the DDS5m. Failure to do so may damage the DDS5m.

3.1 Figure 1 shows a top view of the DDS5m module. Power of +5 Vdc and -5 Vdc is applied through a 5-pin connector. If you are using the NOVATECH provided connector, splice your +5 Vdc supply to the RED wire, your -5 Vdc supply to the BLUE wire and their common-connected returns to the BLACK wires. See the specifications for supply current requirements.

3.2 The quality of the +5V and -5V affects the performance of the DDS5m. The supply should be free of noise and ripple (<50 mV). Even though extensive filtering is used on the DDS5m board, a quiet and well regulated power supply will improve performance. If switching power supplies are used, please verify that your system noise requirements are being met.

3.3 RS232. Connect your host computer to the 9-pin female RS232 connector on the DDS5m. If you are using a PC, a 9-pin monitor extension cable will allow direct connection without the use of a null modem cable or gender changer. If you are using a different computer, please note that data **TO** the DDS5m is on pin 3, data **FROM** the DDS5m is on pin 2 and the **GROUND** return is on pin 5.

If you will be using the rotary switches to set the frequency, leave the RS232 port disconnected. After a reception of any RS232 command, the rotary switches are ignored, until power is cycled or the DDS5m is reset.

3.4 Internal Clock . If you plan to use the DDS5m internal clock, verify that the clock select jumper is in the INT position and that the External Standard input is left unconnected.

3.5 External Standard. If you wish to lock the DDS5m to an External Standard, move the clock select jumper to the EXT position. Select the appropriate jumper position to match your standard (1, 2, 5 or 10 MHz). Apply the input to the EXT SMB. The accuracy and stability of the DDS5m will now track the external standard.

NOTE

The external standard must be accurate to ± 2 ppm for the DDS5m to lock and track.

3.6 Outputs. There are two outputs available on the DDS5m, Sine and ACMOS. The Sine and ACMOS outputs are provided on SMB connectors at the board edge. Simply connect your 50 ohm application cable to the appropriate output. If you are not using the ACMOS output, it is suggested that it be disabled to lower system noise.

3.7 External Update. If the external update connection is left unused, the DDS5m will automatically update its output at the completion of a frequency or phase command. Multiple units can be synchronized by using the External Update. If a 1 MHz External standard is used, all of the synchronized units will stay phase synchronous.

3.9 To use the External Update, connect a CMOS compatible input ($V_{OL} \leq 1.5V$, $V_{OH} \geq 3.5$ V) to the External Update header. Pin 2 is circuit common. Apply a pulse per Figure 2. Do not send an update pulse during a command from the RS232 host.

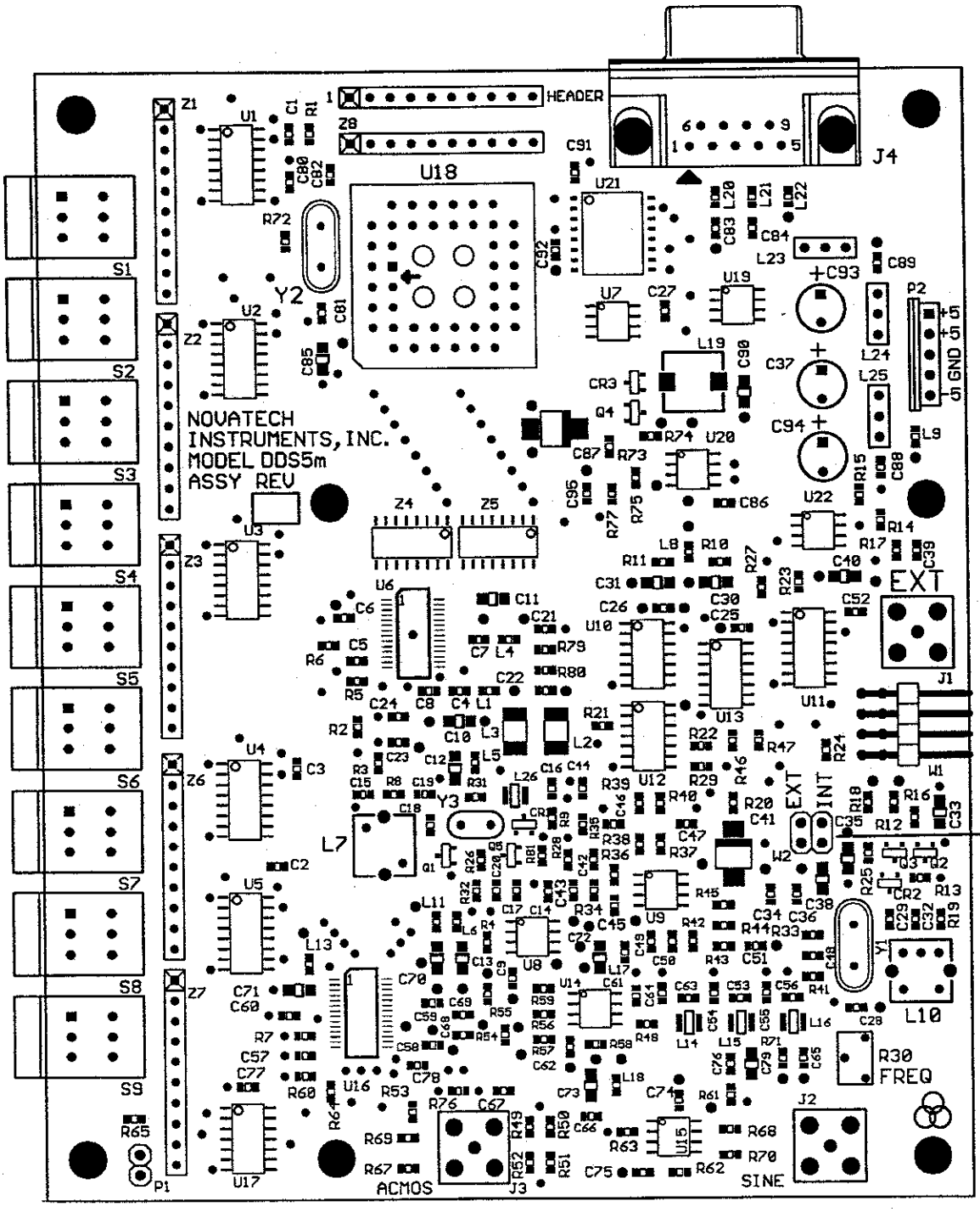
NOTE

The External Update is not ESD protected. This allows for maximum speed.

Figure 1
DDS5m Drawing

2 = Data From DDS5m
3 = Data To DDS5m
5 = Common (Gnd)

RS232
(9 Pin Female)



Power

Rotary Switch Frequency Control

External Input

1 MHz
2 MHz
5 MHz
10 MHz

Internal/ External Clock Select

External Update Input

ACMOS Output

Sine Output

3.10 Mounting. Mounting holes are provided on the board. These holes provide clearance for #4 screws and are electrically connected to circuit common. See Figure 3 for dimensions.

4.0 OPERATION

4.1 After the DDS5m has been installed, all that is required is to send the appropriate RS232 serial commands to the unit or set the rotary switches. See Table 1 for a listing of the DDS5m serial commands.

4.2 The user host computer software must properly format the commands. Incorrect format will result in an error code being returned. See Table 1 for a listing of the DDS5m error codes.

4.3 To assist the user with a quick check of the DDS5m the Quick Basic Programs shown in Table 2 are provided as examples. You may also use a terminal emulation program, set to 9600 baud, 8 bits, 1 stop bit, no parity, with no hardware flow control.

4.4 The `Que` command returns a string of the form `"02625A00 00 A:E E:E"`. The first number is the binary setting in hexadecimal (Hex); multiply by 0.025 Hz to obtain output frequency. The next number is the phase setting in Hex. The next two terms show status of the `A` and `E` commands.

4.5 All other commands require no special considerations. A correctly received and executed command will respond with an `"OK"`. (Except `Que` and `R`)

4.6 The rotary switches allow setting the output frequency to 0.1 Hz resolution. The individual switch setting is indicated by a white mark on the center-left side of the switch. A decimal point is implied one position from the right.

NOTE

Rotary switch settings are ignored after an RS232 command has been received.

5.0 PERFORMANCE TEST

5.1 Install the DDS5m per Section 3 and run the sample program. Allow about 15 minutes for the DDS5m temperature to stabilize in an ambient of 18-28C.

5.2 Connect a frequency counter to the DDS5m SINE output. Set the output frequency to the values shown in Table 3 and verify the limits shown (internal clock mode).

5.3 Move the connection to the ACMOS output. Verify the values in Table 3.

5.4 Using the Frequencies shown in Table 3 verify that the ACMOS output has $V_{OL} \leq 0.8$ and $V_{OH} \geq 3.5$ into an open circuit ($< 30pF, \geq 500$ ohms)

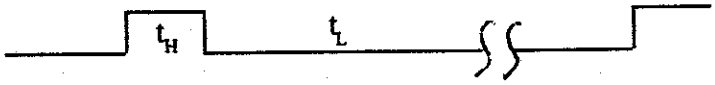
5.5 Connect the Sine output to an RF probe through a 50 ohm feed through termination. Measure the amplitude of 10.000 MHz. Verify 0.5 Vrms $\pm$ 3dB (0.35 - 0.71 Vrms). Disconnect the 50 ohm termination. Verify 1.0 Vrms $\pm$ 3 dB (0.71 - 1.41 Vrms).

5.6 EEPROM Test. Set the output frequency to any value except 1.00 MHz (factory default). Execute the `Save` command. Cycle power. Verify that the frequency out is now the same as that set above. Run the `Que` command. Verify that the value returned is the same as that saved.

5.7 Change the Frequency setting but do not save it. Execute the Reset command (`R`). Verify that the output returns to the last saved value. Cycle power. Again note that the value returns to the last saved value.

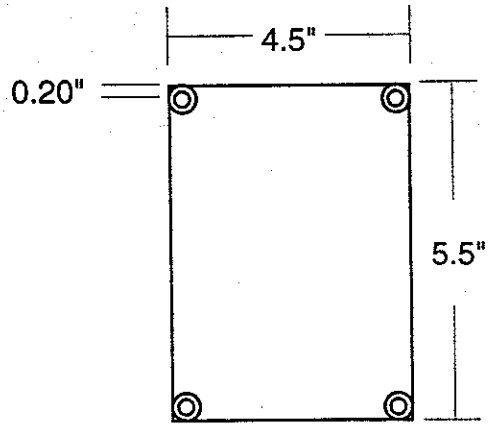
5.8 Disconnect the RS232 cable and cycle power.

Figure 2
External Update Pulse



Note that t_H and t_L must be greater than 25 nanoseconds. The frequency (or phase) will update to the previously loaded value 17 clock cycles following the rising edge. Internal frequency updates are inhibited while the applied update pulse is low (t_L). This signal is pulled up so a switch closure may be used.

Figure 3
DDS5m Mounting Dimensions



Dimensions are in inches.

Adjust the rotary switches. Verify that the output frequency matches the setting (within tolerance).

6.0 CALIBRATION

6.1 The DDS5m contains only three adjustable components. Periodic adjustments are not recommended and should be performed only if the DDS5m fails the performance test or if it has been repaired.

6.2 Install the DDS5m per Section 3 and run the sample program provided.

NOTE

Allow the DDS5m under test to warm up for at least 15 minutes in a 18-28C environment.

NOTE

Best system performance is obtained if the DDS5m is calibrated using the same power supply levels and the same shielding environment as the final installed application.

6.3 Preset R30. Measure the voltage at the junction of R41 and C48. Adjust R30 (FREQ) for +5V $\pm$ 0.25V.

6.4 Adjust L10. Touch a 500 Ω 10x scope probe to the base of Q3. Adjust L10 with a non-metallic adjustment tool to obtain maximum signal. This is a broad peak and need not be set exactly.

6.5 Preset frequency. Monitor the frequency at pin 3 of U11. Adjust R30 for 1 MHz $\pm$ 2 Hz.

6.6 Adjust L7. Monitor the DC voltage at pin 1 of U9. Adjust L7 for a value of 7 volts $\pm$ 3 volts.

6.7 Final frequency adjust. Connect a frequency counter to the SINE output. Readjust R30 if necessary to obtain 1 MHz $\pm$ 2 Hz.

Table 1
RS232 Commands

F XX.XXXXXXXXX	Sets frequency in MHz. Software sets to nearest 0.025 Hz setting. 1 MHz default. Decimal point required.
E D	Disables echo.
E E	Enables echo.
R	Reset. Same as cycling power.
P N	N is integer 0 to 31. Phase is set to N*11.25. (N*Pi/16 radians)
A E	Enables ACMOS/TTL output.
A D	Disables ACMOS/TTL output. Output is set low. (Lowers system noise for critical applications)
SAVE	Save current output. Used as default on next power up.
QUE	Return last saved frequency and phase.

The commands are not case sensitive. There must be a space after each command except Reset, Save and Que. End with CR.

ERROR CODES RETURNED

?0	Unrecognized Command
?1	Bad Frequency
?2	(Not Used)
?3	Input line to long
?4	Bad Phase

Table 2
Sample Programs

```
'This QBASIC program named "dds5m_ex.bas" sends commands to
'the serial port for testing the DDS5m module.

CLS
LOCATE 1,1
OPEN "COM1:9600,n,8,1,cd0,cs0,ds0,op0,rs" FOR RANDOM as #1
PRINT #1, ""
LINE INPUT #1, a$
DO WHILE 1 = 1
PRINT
INPUT "Enter command to send to DDS6m: ", cmnd$
PRINT #1, cmnd$
LINE INPUT #1, resp$
PRINT resp$
LOOP
END
```

Table 2 (Continued)
Sample Programs

```
'This QBASIC program named "swp5m.bas" can be used to cause the DDS5m to sweep
'the output frequency and to set up the DDS5m for use with an external clock.
CLS
LOCATE 1, 1
OPEN "com1:9600,n,8,1,cd0,cs0,ds0,op0,rs" FOR RANDOM AS #1
INPUT "What is your clock frequency (0 for internal): ", clock#
INPUT "enter initial frequency (in MHz): ", freq1#
INPUT "enter final frequency (in MHz): ", freq2#
INPUT "enter number of steps: ", steps#
stepsize# = (freq2# - freq1#) / steps#
'
' scale all the values based upon the clock frequency
defclock# = 107.3741824#
IF clock# = 0# THEN goto 10
scale# = defclock# / clock#
freq1# = scale# * freq1#
freq2# = scale# * freq2#
stepsize# = scale# * stepsize#
'
10 PRINT #1, "e d"
LINE INPUT #1, resp$
PRINT "Response ", resp$
f# = freq1#
WHILE f# <= freq2#
    PRINT #1, "f ";
IF f# < 10 THEN PRINT #1, USING "#.#########"; f#
IF f# < 10 THEN PRINT , USING "#.#########"; f#
IF f# >= 10 THEN PRINT #1, USING "##.#########"; f#
IF f# >= 10 THEN PRINT , USING "##.#########"; f#
    LINE INPUT #1, resp$
    PRINT "Response "; resp$
    'wait for 250 ms on each step
       t0 = TIMER
       WHILE TIMER - t0 < .25
       WEND
     f# = f# + stepsize#
WEND
'reset to enabled echo
PRINT #1, "e e"
PRINT "Done"
STOP
```

Table 3
Performance Test Settings

Frequency (MHz)	As Shipped	One Year
1.000	0.999995 - 1.000005	0.999990 - 1.000010
5.000	4.999975 - 5.000025	4.999950 - 5.000050
10.000	9.999950 - 10.000050	9.999900 - 10.000100
20.000	19.999900 - 20.000100	19.999800 - 20.000200
40.000	39.999800 - 40.000200	39.999600 - 40.000400

Note: Tolerances exclude frequency counter error

Table 4
Recommended Test Equipment

Item	Specification	Recommended
Oscilloscope	500 MHz, 50 ohm Input	Tektronix TDS520 w/P6156A 10x Probe.
RF Probe	100kHz - 50 MHz	Tektronix P6420 HP 34301A
DMM	3 1/2 Digits, dB	HP34401A
50 ohm Termination	50 ohm, 2%	Tektronix 011-0049-01 Pomona 4119-50
Frequency Counter	50 MHz	HP53131A-001
Host Computer		

WARRANTY

NOVATECH INSTRUMENTS, INC. warrants that all instruments it manufactures are free from defects in material and workmanship and agrees to replace or repair any instrument found defective during a period of one year from date of shipment to original purchaser.

This warranty is limited to replacing or repairing defective intruments that have been returned by purchaser, at the purchaser's expense, to NOVATECH INSTRUMENTS, INC. and that have not been subjected to misuse, neglect, improper installation, repair alteration or accident. NOVATECH INSTRUMENTS, INC. shall have the sole right to final determination regarding the existence and cause of a defect.

This warranty is in lieu of any other warranty, either expressed or implied, including but not limited to any warranty of merchantability or fitness for a particular purpose. In no event shall seller be liable for collateral or consequential damages. Some states do not allow limitations or exclusion of consequential damages so this limitation may not apply to you.

All instruments manufactured by NOVATECH INSTRUMENTS, INC. should be inspected as soon as they are received by the purchaser. If an instrument is damaged in shipment the purchaser should immediately file a claim with the transportation company. Any instrument returned to NOVATECH INSTRUMENTS, INC. should be shipped in its original shipping container or other rigid container and supported with adequate shock absorbing material.

This warranty constitutes the full understanding between NOVATECH INSTRUMENTS, INC. and the purchaser and no agreement extending or modifying it will be binding on NOVATECH INSTRUMENTS, INC. unless made in writing and signed by an authorized official of NOVATECH INSTRUMENTS, INC.

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