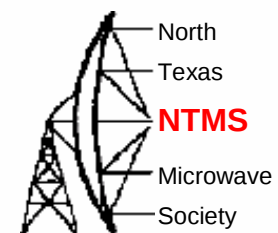


WSJT Operation (Meteor Scatter)

Wes Atchison

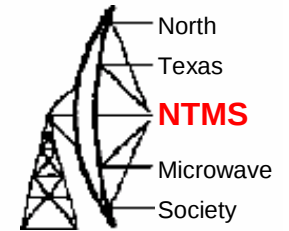
WA5TKU

February 12, 2011



History

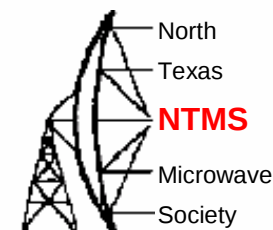
Meteor Scatter



- First QST Articles in April 1953, W6QYT & W6POH Was for 15 & 20 meter Operation
- W4AO, W4HHK & W2UK Pioneered 144 MHz Contacts & Procedures
- Contact Procedures Has Changed Little Since
- WSJT Contact Procedures Based on Early Work

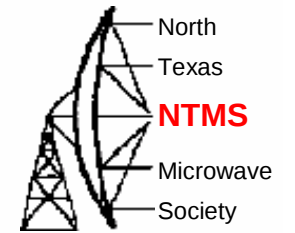


CONDUCTED BY EDWARD P. TILTON,* WHDQ



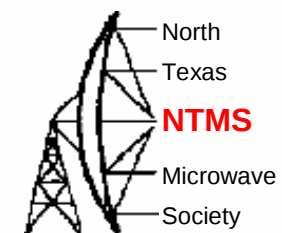
Nov 1957 QST

FOR AN ART that has been known only about four years, v.h.f. meteor-scatter communication has come a long way. When the sharp “ping” of meteor signals was first observed on 144 Mc. back in 1953, many people refused to believe that meteors stirred up enough ionization to reflect signals at so high a frequency. That these were, in fact, signals of meteoric origin took some demonstrating. The work of W4AO, W4HHK, W2UK and other pioneers in this field is a chapter in the history of amateur radio in which we may all take pride.

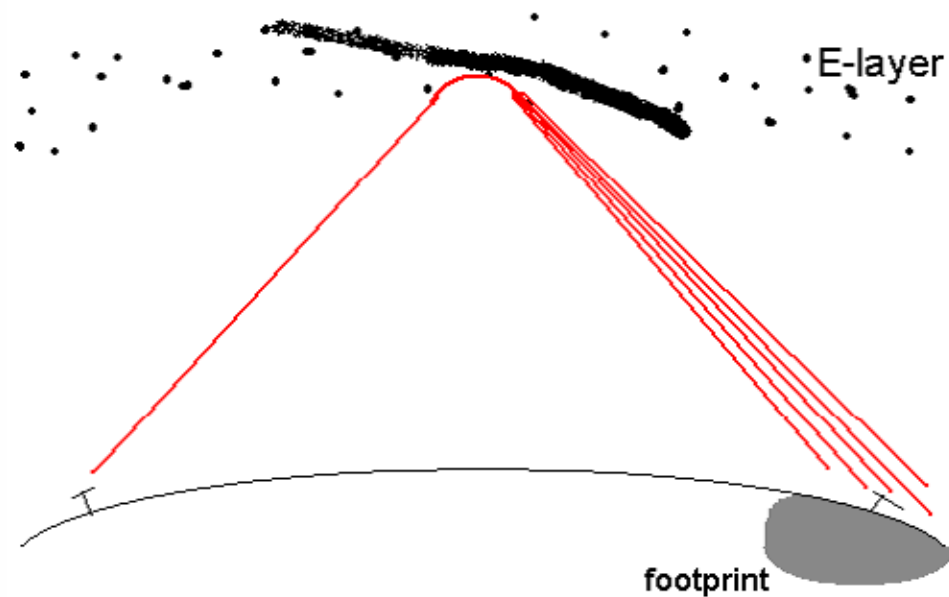


Basics

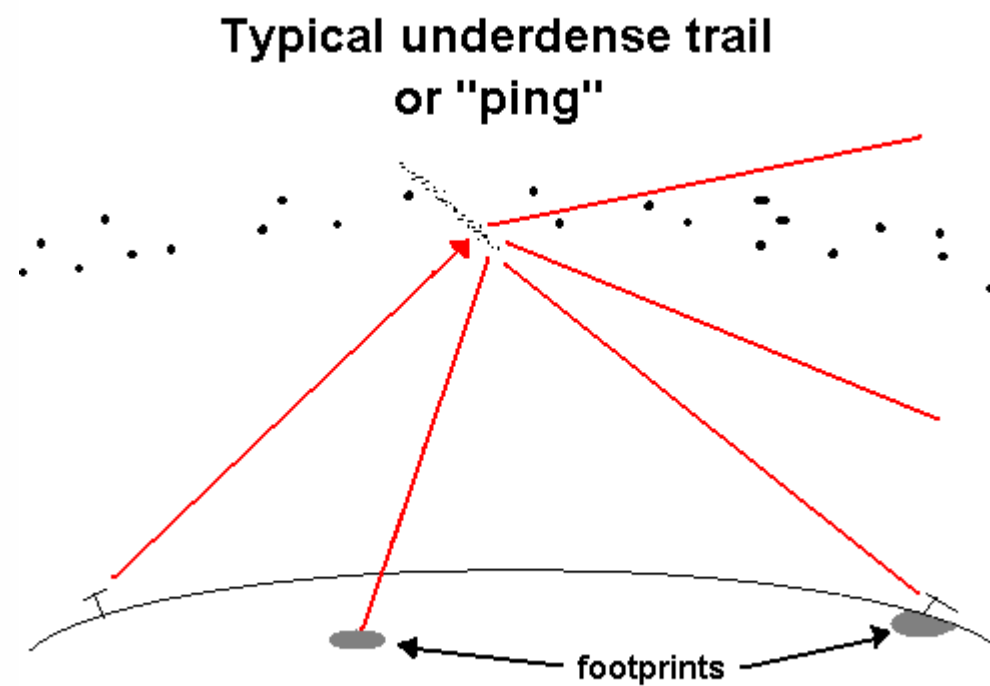
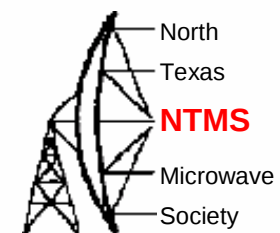
Meteor Trail



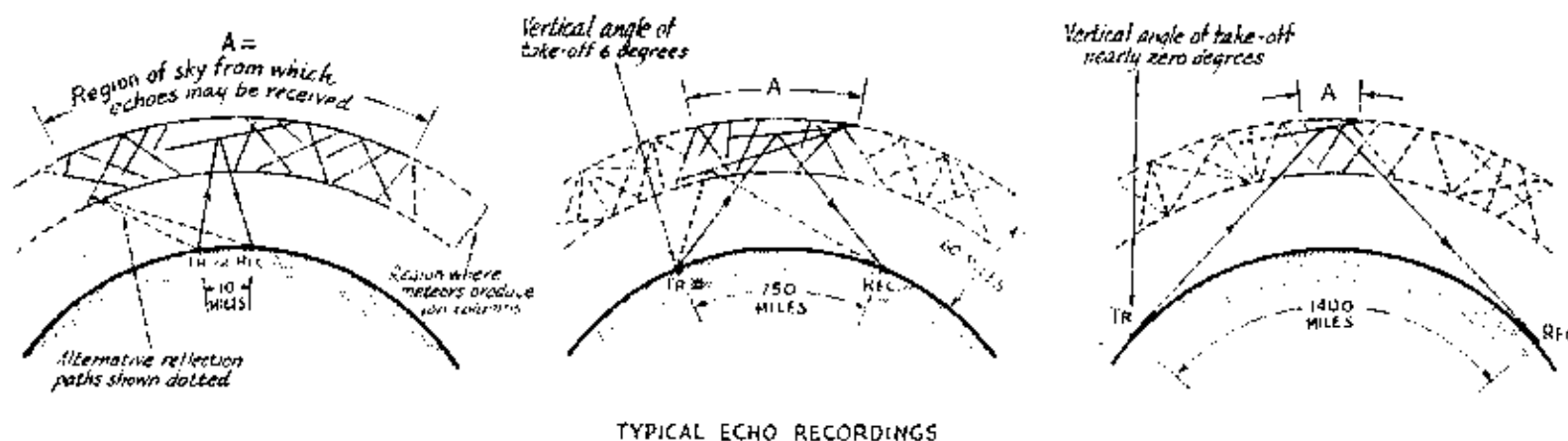
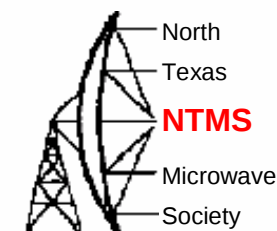
Typical overdense meteor trail
or "blue whizzer"



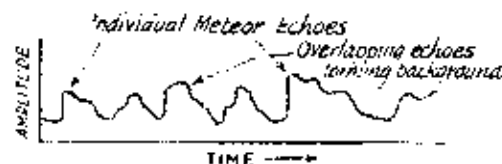
Meteor Trail



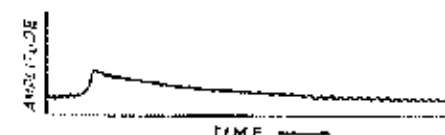
QST April 1953



- ECHOES:
- (A) Strong
 - (B) Frequent
 - (C) Short duration



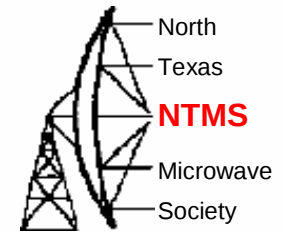
- ECHOES:
- (A) Strong when beam with low vertical angle used
 - (B) Frequent
 - (C) Long duration



- ECHOES:
- (A) Weak, because vertical angle so low
 - (B) Infrequent -- small area contributing echoes
 - (C) Long duration

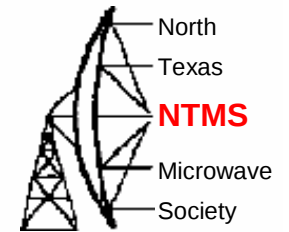
Fig. 5 — Effect of distance on meteor echo behavior, for a given frequency and power.

Major Meteor Showers



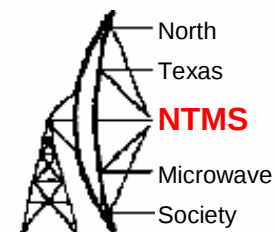
Some Meteor Showers			
Name	Date of Maximum	Meteors / Hour at Max	Parent
Quadrantids	Jan. 4	110	-
Perseids	Aug. 12	68	Comet 1862 III
Orionids	Oct. 21	30	Comet Halley
Leonids	Nov. 17	10	Comet P/Tempel-Tuttle
Geminids	Dec. 14	58	3200 Phaethon

Random Meteors

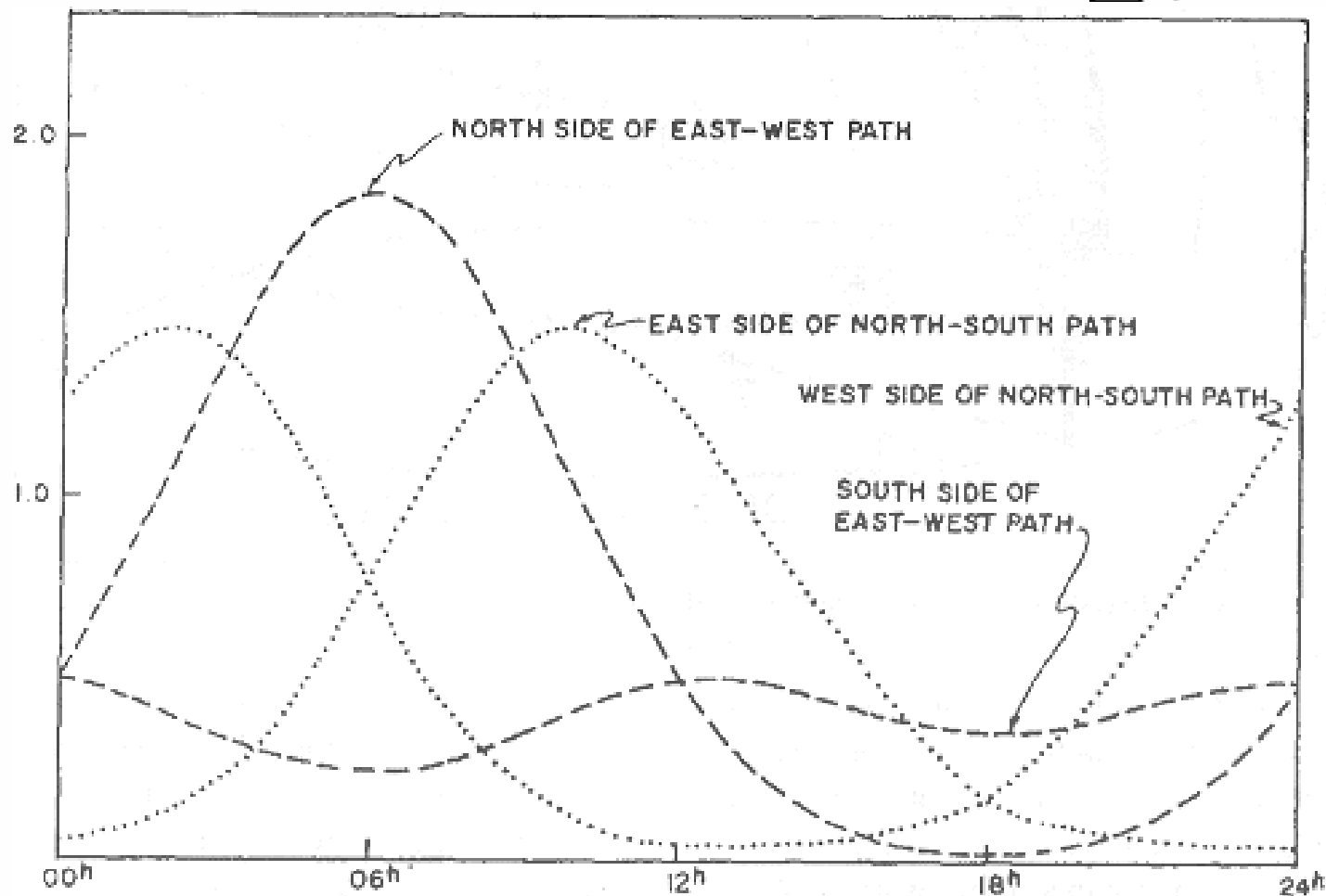


- For a north-south path the west side is the most productive from 18H to 06H local and it peaks at 03H.
- The east side of a north-south path is better from 06H to 18H and peaks at 10-11H.
- Max. meteor reflection counts on a north-south path is not at 06H local time!
- For an east-west path the north side is best from 00H to 12H and it peaks at 06H.
- The south side is best from 12H to 24H, but is on a quite even and low level.

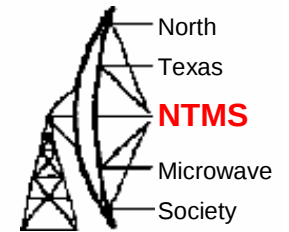
Random Meteors



- This drawing shows predicted diurnal variations in random meteor counts for a path length in the order of 1000 km.

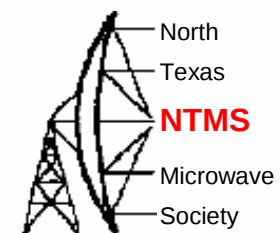


Random Meteors



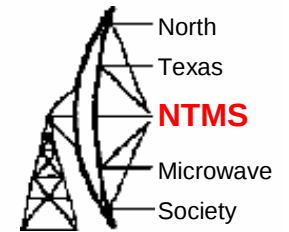
- The afternoon and early evening has fewer meteors, but the reflections should be longer, as the trails tend to form at lower heights, where the trails persist longer.
- Longer reflections are no disadvantage to making QSO's, so there is no reason to give up making QSO's in the evening.

W5HN



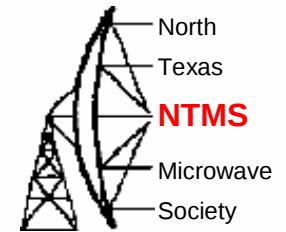
WSJT

WSJT



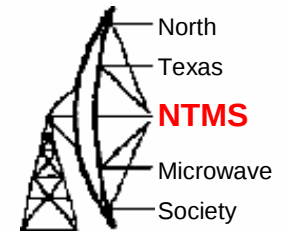
- “Weak Signal Joe Taylor” = WSJT
- Developed by Joe Taylor, K1JT
- Current Release is Version 9
- Some People Still Use Version 7
- Both Version Compatible – V9 Has Enhanced FSK441 Decoder & New Mode
 - ISCAT New to V9 – Replaces JT6M
- Uses Computer Sound Card

WSJT Meteor-Scatter QSO



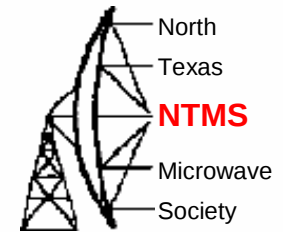
- Very similar to SSB meteor-scatter operation
- Operators send information based upon what they have copied from the other station.
- QSO is complete when **both** stations have received complete callsigns, a piece of information (usually report), and a confirmation that it was received ("roger").

WSJT Meteor-Scatter QSO



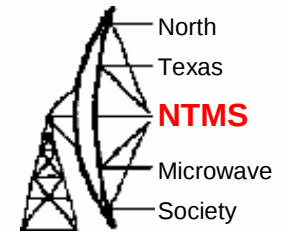
- 30-second sequences are standard.
- Western-most station transmits first. This is in the Western hemisphere.
- DXpeditions usually run all schedules and CQ's on the same frequency and period, regardless of direction.
- "Regular" CQ's can be either first or second period. This eases QRM (contests/showers)

Typical QSO Sequence



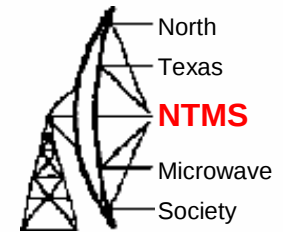
- If you have copied.... Then Send
- Nothing..... Callsigns Only
- Partial callsigns..... Callsigns Only
- Both callsigns..... Calls + Report (or Grid)
- Both calls and report... "R" + Report
- "R" + report..... "RRR"
- "RRR"..... "73" QSO is Complete

FSK441



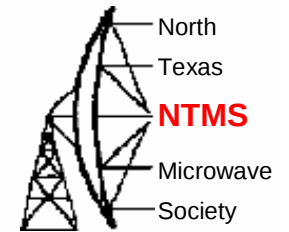
- “FSK...” –it uses frequency shift keying. You can think of it as fancy RTTY, however, FSK441 switches among four tones rather than alternating between two.
- Tones: 882Hz, 1323Hz, 1764Hz, 2205Hz.
- “...441” –Each character takes about 2.3ms to send. Each character is composed of three tones. That’s 441 baud

FSK441



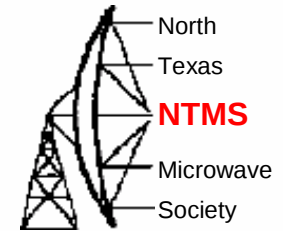
- Code only supports characters we are interested in sending: callsigns, signal reports, and very short messages.
- Uses the PUA43 alphabet: A-Z, 0-9, space, period, comma, ?, /, #, and \$. No formatting characters, such as <CR> or <LF>.
- No stop bits: synchronization achieved with no overhead!

RTTY vs FSK441 Data Format



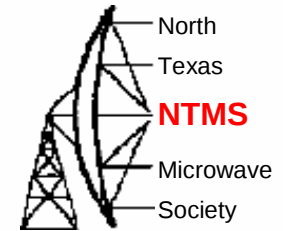
	<u>RTTY (5-bit)</u>		<u>FSK441 (3-bit)</u>
A	00011	A	101
B	11001	B	102
C	01110	C	103
Z	10001	Z	231
6	10101	6	012
<SP>	00100	<SP>	033 *

FSK441



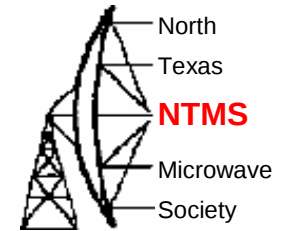
- Each character in the FSK441 code contains at least two different frequencies—no “000” “111” “222” or “333”.
- These characters are reserved for “shorthand” messages: “R26” “R27” “RRR” “73”.
- If one sends one of these messages in a loop, the result is a pure single-frequency carrier. (Hence the name!)

FSK441



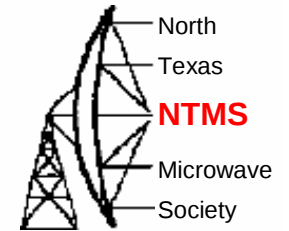
- Space is encoded as “033”.
- No character starts with a “3”.
- All messages contain at least one space. If the user does not enter one, the program will add one to the end of the message.
- When WSJT finds a signal, it “looks” for the sequence “033”. This is the point of synchronization.

FSK441



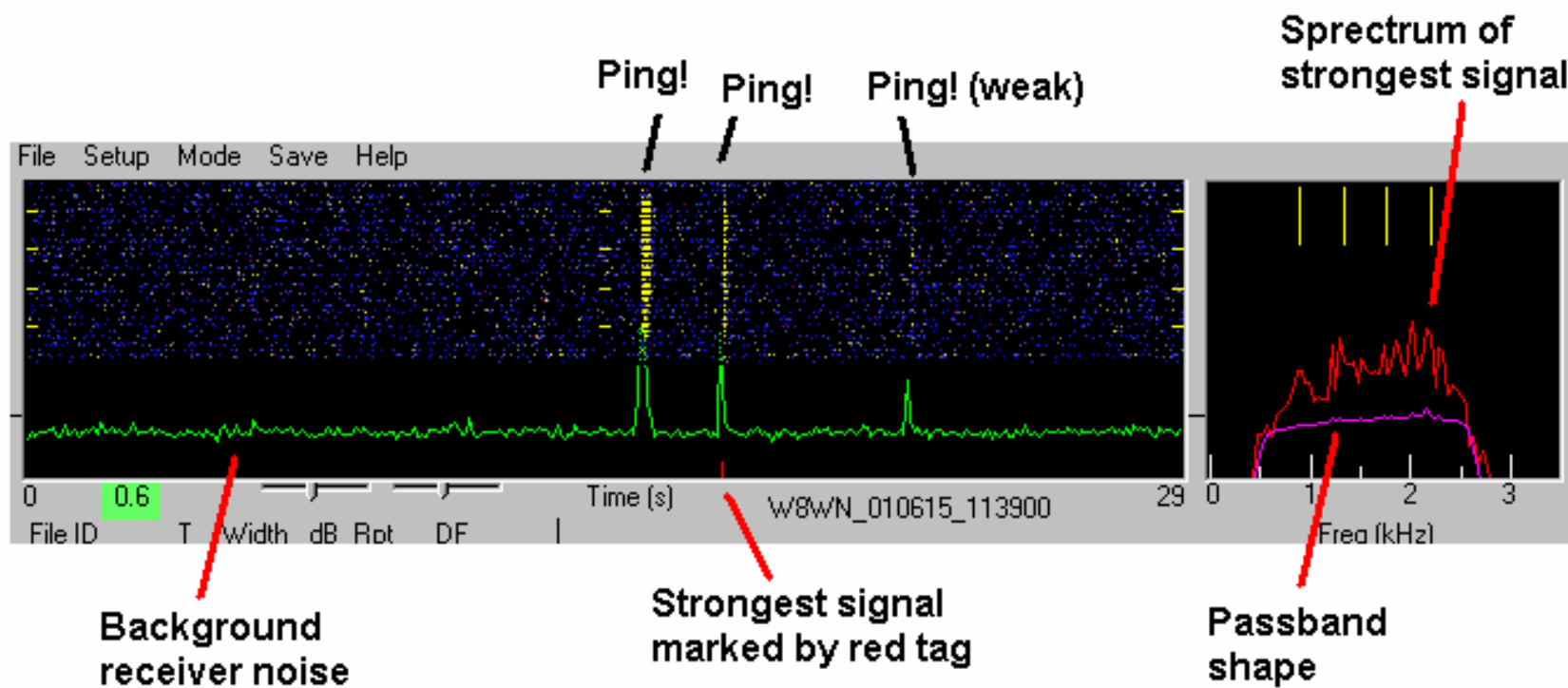
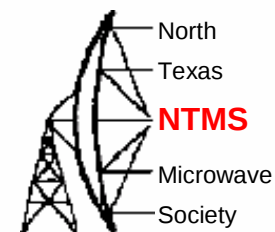
- These messages are shorthand for the most common messages in an FSK441 sked.
- WSJT can use a separate algorithm to look for single-tone messages, which means better S/N than with the multi-tone encoding.
- It *can* occasionally result in false signals.
- You have to use your ham skills: *Listen!*

FSK441

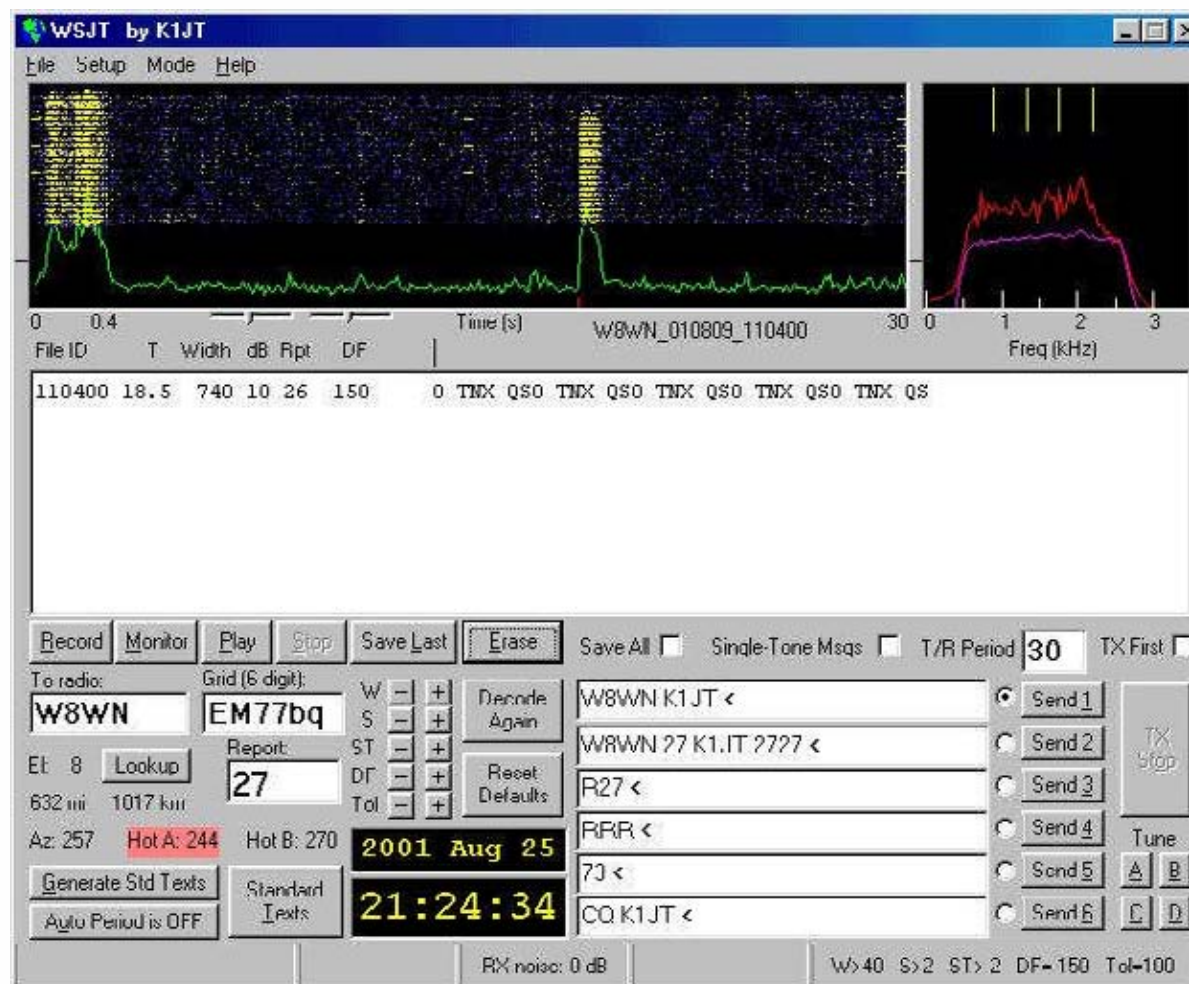
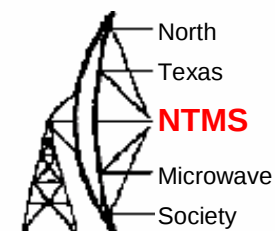


- Four-tone FSK: 882, 1323, 1764, 2205 Hz
- Three tones or “symbols” per character
- Keying rate 441 baud
- Transmission rate 147 cps
- Detection bandwidth 4×441 Hz
- Short messages sent repeatedly
- 30s T/R sequences

WSJT FSK441 Window

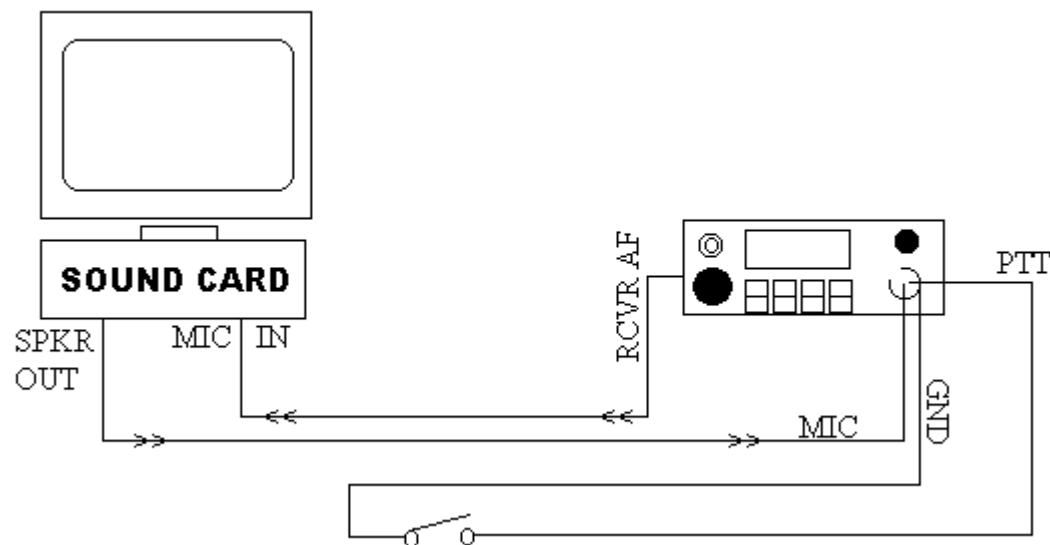
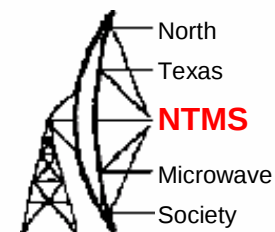


W8WN QSO with K1JT



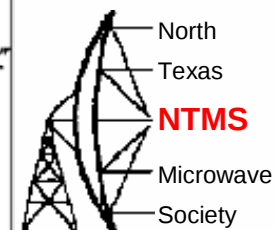
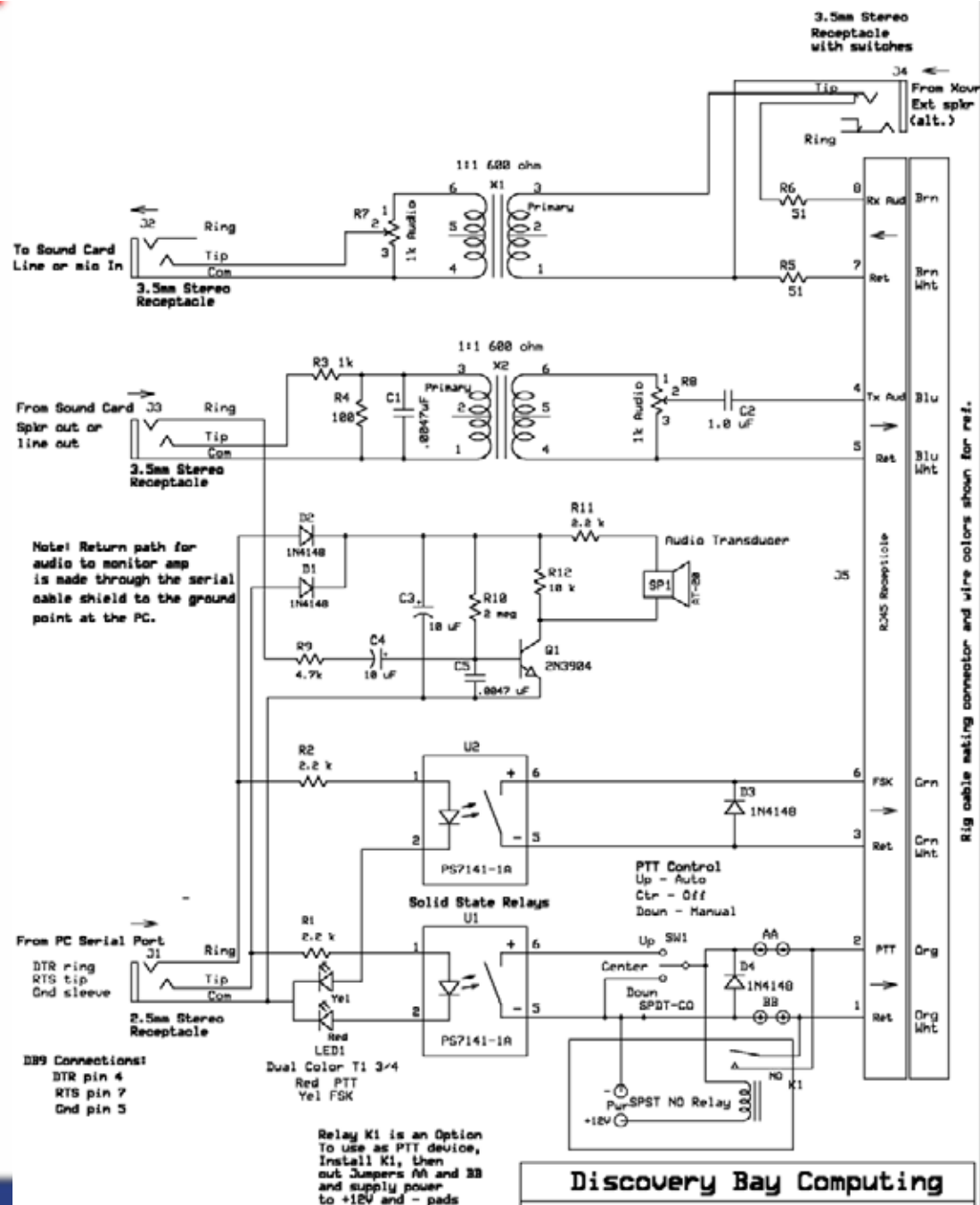
SETUP

Very Basic Setup Connections

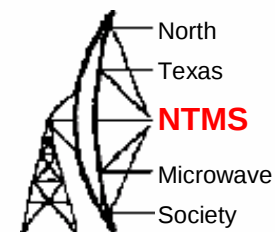


Recommend Connection of PTT to Computer via Serial Port
for Automatic Operation

Sound Card Interface Circuit by KK7UQ



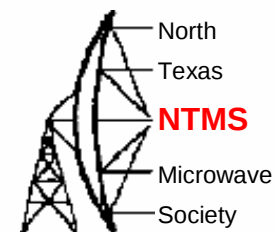
Audio Interface



- Top Box - KK7UQ Sound Card Interface
- Bottom Box- 4 Port Data Switch – 15 Pin DB Connectors



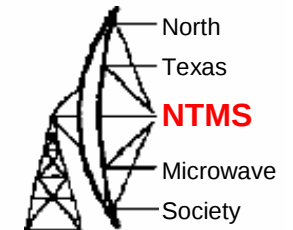
Audio Interface



- Rear View of Sound Card Interface



Sound Card Selection



The screenshot shows a Windows XP desktop with various icons. A window titled 'WSJT9' is open, displaying the following text:

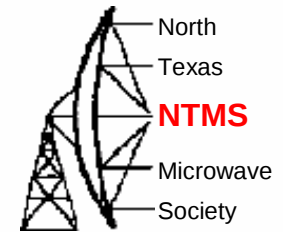
```

=====
WSJT Version 9.02 r2226 , by KI1JT
Revision date: 2010-10-25 13:46:52 -0400 (Mon. 25 Oct 2010)
Run date: Tue Feb 08 01:05:12 2011 UTC
=====
Audio Device      Input Channels  Output Channels  Device Name
-----
0                2              0              Microsoft Sound Mapper - Input
1                2              0              SignalTel Audio
2                0              2              Microsoft Sound Mapper - Output
3                0              2              SignalTel Audio

User requested devices:  Input = 0  Output = 0
Default devices:        Input = 0  Output = 2
Will open devices:      Input = 0  Output = 2
Audio streams running normally.
=====
C:\Program Files\Common Files\Microsoft Shared\Windows Live
C:\WINDOWS\system32
  
```

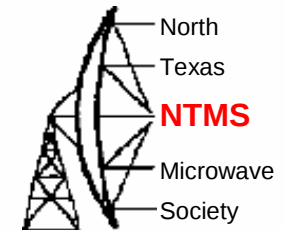
The taskbar at the bottom shows the Start button and several open applications: NTMS - Window..., Google Custom..., Inbox - Microso..., Microsoft Powe..., WSJT9, WSJT 9.02..., and SpecJT by K... The system clock shows 7:45 PM.

Setting RX Level



- 4 Possible Locations to Adjust RX Levels
 - Digital Gain Slider in SpecJT Window
 - Options Pull Down in SpecJT Window Opens Sound Card Adjustment Sliders
 - Pot on Sound Card Interface Box
 - If Using Speaker or Headphone as Input Source to Sound Card Interface Box Use Audio Gain on Receiver

Setting RX Level



WSJT 9.02 by K1JT

File Setup View Mode Decode Save Band Help

Sensitivity/Squelch Level

0.9800 1.0068 FSK441 Freeze DF: 0 Rx noise: 30 dB T/R Period: 30 s Receiving

•Adjust RX Level for RX Noise 0 dB with No Signal

WSJT 9.02 by K1JT

File Setup View Mode Decode Save Band Help

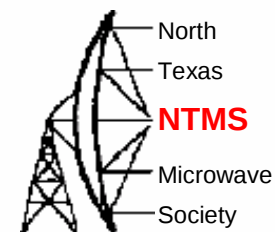
Log QSO Stop Monitor Decode Erase TxStop

To radio: W5HN Lookup
Grid: EM77bq Add
Hot A: 244 Az: 257 El: 8 632 mi
2011 Feb 08 01:15:46 Dseq: 0.0
S 1 Zep
Tol: 400 Rx ST
Tx First Tx ST
Rpt: 26
Gen Msgs Auto is Off

W5HN K1JT Tx1
W5HN K1JT 26 Tx2
R26 Tx3
RRR Tx4
73 Tx5
CG K1JT Tx6

start NTMS - Window... Google Custom ... Inbox - Microso... Microsoft Powe... WSJT9 WSJT 9.02 ... SpecJT by K...

Sound Card RX Level



The screenshot shows the SpecJT software interface. The main window has a title bar 'SpecJT by K1JT'. Below the title bar is a menu bar with 'Options'. The main area is a large black rectangle. At the top of this area is a frequency scale from 5 to 30 MHz. Below the black area is a 'Digital Gain' slider set to -20 dB. A 'Gain' button is next to it. A timestamp '01:25:06' is displayed in the center. A 'Recording Control' window is open in the bottom left, showing 'Stereo Mix', 'Line In', and 'Microphone' sections with balance and volume sliders. The 'Line In' section is selected. The Windows taskbar at the bottom shows the 'start' button and several open applications: 'NTMS', 'Google C...', 'Inbox + M...', 'Microsoft...', 'WSJT9', 'WSJT 9...', 'SpecJT ...', 'Recordin...', and 'Recordin...'. The system clock shows '7:25 PM'.

Options –
Select RX
Level Control
for Sound
Card

Options: Time: 19.9 s Freq: 0 Hz BW < | > Speed: C 1 C 2 C 3 C 4 C 5 C H1 C H2
5 10 15 20 25 30

Digital Gain 01:25:06 -20 dB

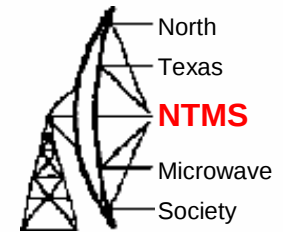
Gain

Recording Control
Options: Help
Stereo Mix Line In Microphone
Balance: Balance: Balance:
Volume: Volume: Volume:
Select Select Select
Advanced
SigmaTel Audio

Sound Card
Control

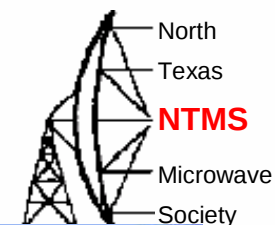
Digital Gain Control
Slider in WSJT
Software

Sound Card TX Level

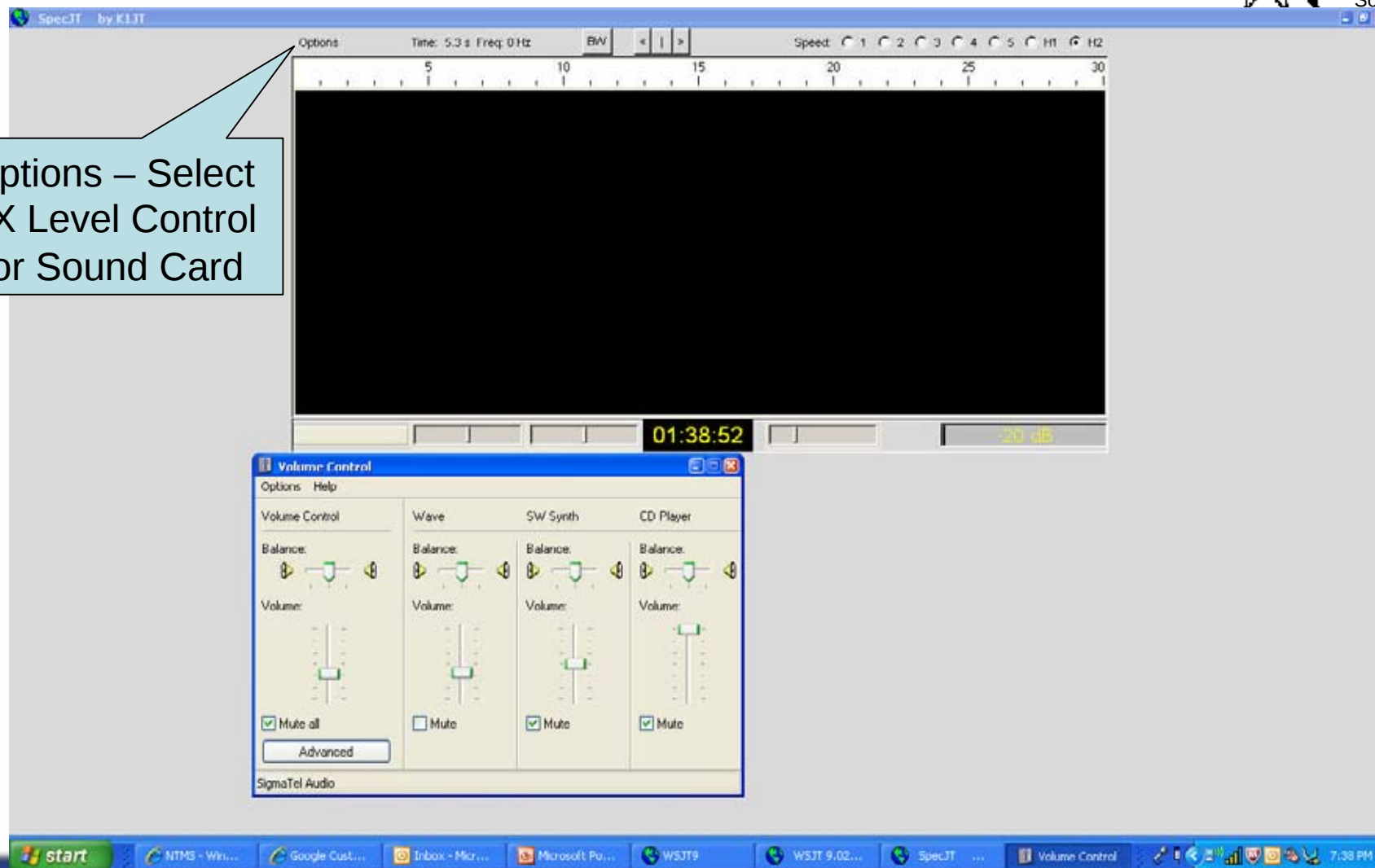


- 3 Possible Locations to Adjust TX Levels
 - Options Pull Down in SpecJT Window Opens Sound Card Adjustment Sliders
 - Pot on Sound Card Interface Box
 - Mic Gain Control on Radio May Work Depending on Radio and Method of Interfacing Sound Card to Radio

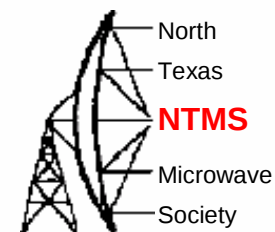
Sound Card TX Level



Options – Select
TX Level Control
for Sound Card



WSJT Setup Options



Choose Options in Setup Pull Down

Input Callsign, Grid Locator, PTT Port, Audio In, Audio Out, Rate In, Rate Out & PTT Line

WSJT 9.02 by K1JT

File Setup View Mode Decode Save Band Help

Station parameters:

- My Call: W5TKU
- Grid Locator: EM13L
- ID Interval (m): 10
- PTT Port: 1
- Audio In: 0
- Audio Out: 2
- Rate In: 1.0
- Rate Out: 1.0
- PTT line: ☐ DTR ☒ R
- Distance unit: ☒ mi ☐ km

Message templates for FSK441, ISCAT

- ☐ EU ☒ NA
- ☒ Report ☐ Grid
- ☐ My tag ☐ His tag
- Reset
- Reset and Gen Msgs
- Tx 1: %T %M
- Tx 2: %T %M %R
- Tx 3: R%R
- Tx 4: RRR
- Tx 5: 73
- Tx 6: CQ %M

Miscellaneous

- DXCC prefix:
- Source RA: 0
- Source DEC: 0
- AzDir: C:\Program
- Echo Avg (m): 1
- RIT (Hz): 0
- Other (Hz): 0

Monitor Decode Erase TxStp

To radio: W5WN Lookup

Grid: EM77bq Add

Hot A. 73 Az. 62 El. 7 709 mi

2011 Feb 08 01:50:31 Dsec 0.0

Gen Msgs Auto is Off

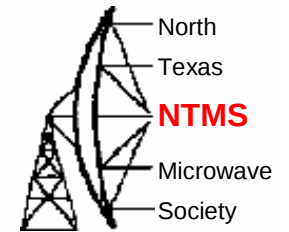
0.9799 1.0067 FSK441 Freeze DF: 0 Rx noise: -30 dB T/R Period: 30 s Receiving

Weather Ninja Skype

WSJT9 NOOK for PC

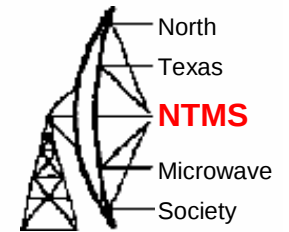
start NTMS - Win... Google Cust... Inbox - Mic... Microsoft Po... WSJT9 WSJT 9.02... SpecIT... Options 7:30 PM

WSJT Setup Options



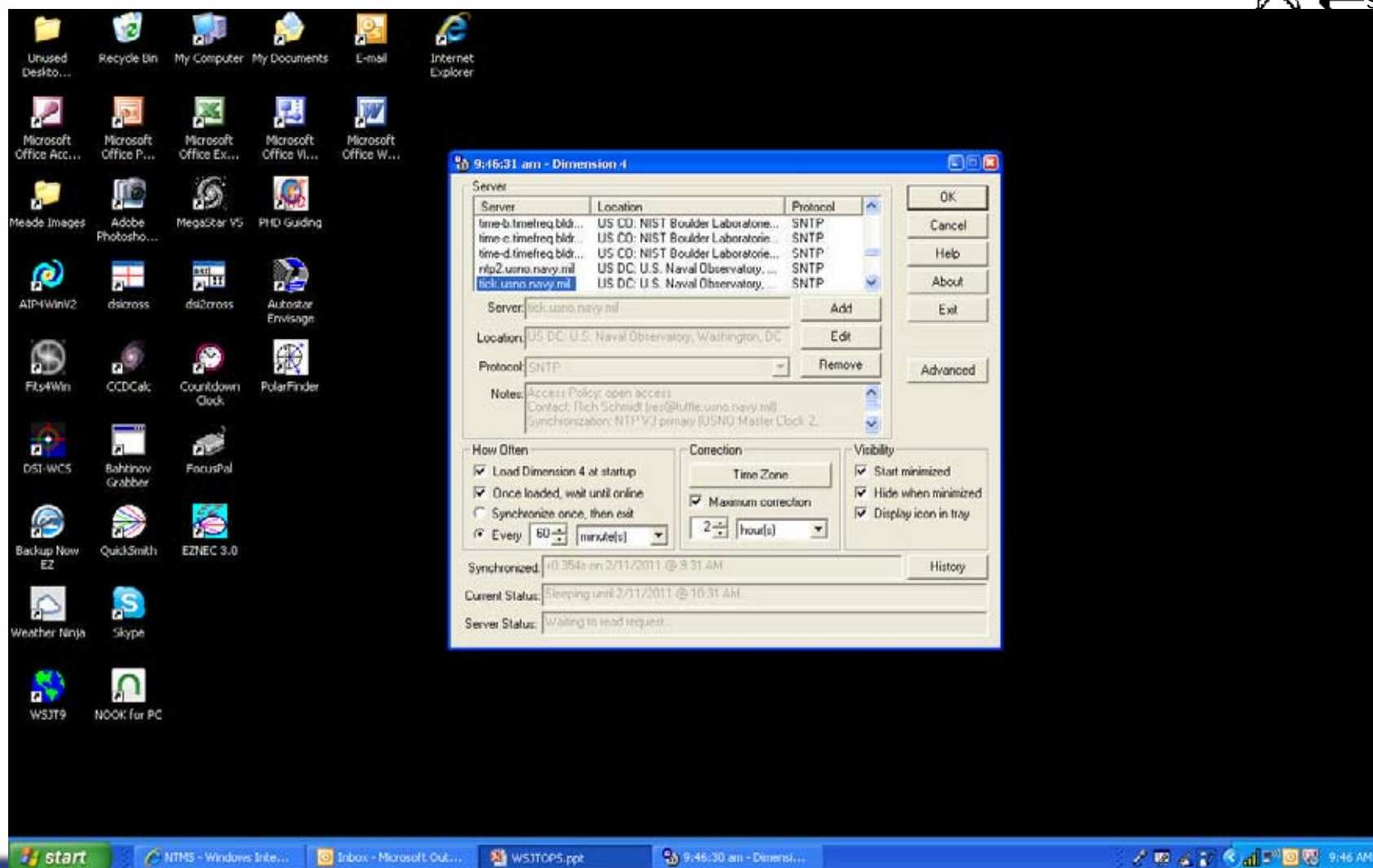
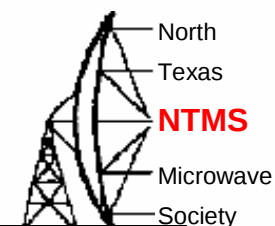
- Options Pull Down Window
 - Input Your Callsign
 - Input Your Grid Square (6 digit)
 - Input PTT Port – Look in Device Manager for Port Information
 - Set Audio In & Out to Match WSJT Sound Card Window for Sound Card of Choice
 - Rate In & Out – See WSJT Manual
 - PTT Line Selection Depends on Interface Box Design
 - My Box has DTR & RTS Diode ORed

Station Requirements



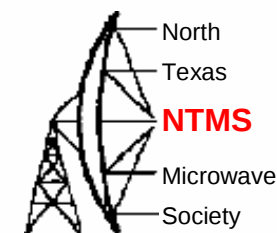
- Radio with Short Term Stable Frequency
- PC with Sound Card
- Radio to Sound Card Interface
- Ability to Sync PC Clock to Stable Source
 - Short Term Stability Most Important ie < 200 Hz/Hour

Dimension 4



Operation

N0UK Reflector for Coordination



Ping Jockey Central by N0UK - Windows Internet Explorer

http://www.pingjockey.net/cgi-bin/pingtalk

File Edit View Favorites Tools Help

Ping Jockey Central by N0UK

Ping Jockey Central.



Relief page	Skeds in-progress	CQ Announcements	JT65 Link
Refresh	Look back	Distance/Bearing Locator	Who's Earwigging?
Update User details	AA1YN Callsign database	Wes, WA5TKU TX EM13ii	Refreshed 01/24 14:47

You - YES YOU - must read this! and also this.

This page is to be used only for the purposes of discussing matters related to amateur radio meteor scatter communications. Any non-meteor scatter use is strictly prohibited.

That means **DO NOT USE THIS PAGE TO WORK JT65 or for General chit-chat.**

Remember, in North America, 50.260MHz and 144.140MHz are calling not operating frequencies.

Exchanging any contact details on here before you're complete, invalidates the contact, and, if it's not HIGH-SPEED METEOR SCATTER, it doesn't belong here!

Enter your message here

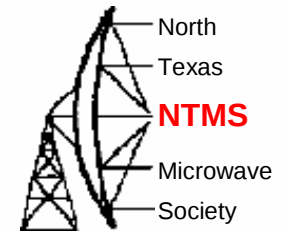
MM/DD UTC

```

01/24 14:30 bbl (KS7DX/6M Barry NV DM26ic 76.3.136.251)
01/24 14:21 lol (KS7DX/6M Barry NV DM26ic 76.3.136.251)
01/24 14:19 not much gain on the antenna in the box (K0TTP Larry MO EM48rj 70.130.150.192)
01/24 14:19 same here but time is my problem - not the wx (KS7DX/6M Barry NV DM26ic 76.3.136.251)
01/24 14:16 i need so nice wx putting up another tower (K0TTP Larry MO EM48rj 70.130.150.192)
01/24 14:06 40s here Larry and heading to mid 60s (KS7DX/6M Barry NV DM26ic 76.3.136.251)
01/24 14:03 ice here this am (K0TTP Larry MO EM48rj 70.130.150.192)
01/24 13:55 cul Bill (KS7DX/6M Barry NV DM26ic 76.3.136.251)
01/24 13:54 CUL Barr et al., off board, bbl (W5WVO/6M/QRO Bill NM DM65qh 65.19.54.50)
01/24 13:49 Once I get the 6 meter array finished I'll think about HF (KS7DX/6M Barry NV DM26ic 76.3.136.251)
01/24 13:46 Yeah, or me either! But soon... next few months, now that i'm making a little money again (W5WVO/6M/QRO Bill NM DM65qh 65.19.54.50)
01/24 13:46 I've worked DXCC on JT65 though for what's it worth from here (KS7DX/6M Barry NV DM26ic 76.3.136.251)
01/24 13:46 I really don't have any decent HF antennas out here :- (KS7DX/6M Barry NV DM26ic 76.3.136.251)
  
```

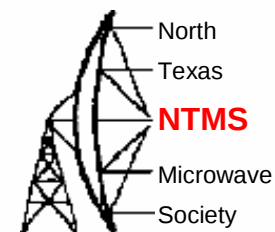
start | Inbox - Microsoft Out... | Ping Jockey Central b... | W5TTPS.ppt | PackRats_Sep05_K13... | 8:47 AM

Logger Etiquette



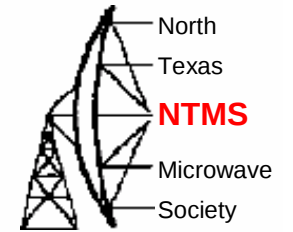
- Statements Best Not Used
 - • Are you sending single tones now?
 - I can hear you now
 - I have up to 10db burst no decodes
 - Just got a big one!
 - Keep going
 - Your DF is 102
 - Leave your antenna there!
 - Not hearing anything, moving to Hot A
 - I am getting some single tone, is that you?
 - Wow! You hit me hard, 13db!
 - Keep going we are almost finished.
 - There is 500 watts out have anything yet?

2011 Major Meteor Showers



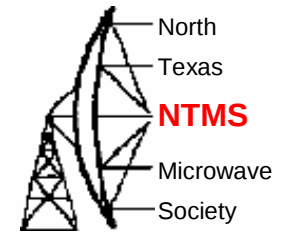
Quadrantids (QUA)	Jan 01-Jan 10
Lyrids (LYR)	Apr 16-Apr 25
Eta Aquarids (ETA)	Apr 28-May 21
Delta Aquarids (SDA)	Jul 21-Aug 23
Perseids (PER)	Jul 13-Aug 26
Orionids (ORI)	Oct 04-Nov 14
Leonids (LEO)	Nov 07-Nov 28
Geminids (GEM)	Dec 04-Dec 16
Ursids (URS)	Dec 17-Dec 23

Calling Frequencies & Modes



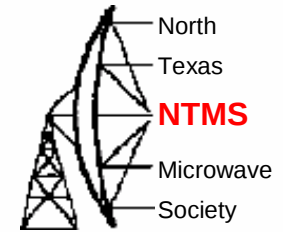
Band	Call Freq.	Modes (WSJT 9)
Six Meters	50.260	FSK441, JT6M or ISCAT
Two Meters	144.140	FSK441
222	222.085	FSK441

Calling CQ – Offset Method



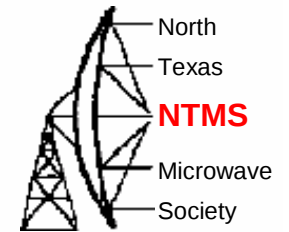
- " Knowing how to properly call CQ is just as important as knowing where to call CQ"
According to WA5UFH
- CQ 280 WA5UFH not CQ U20 WA5UFH
– Recent Change in Offset Calling Procedure
- Station Calling CQ listens on 50.280
- When Answering Station is Heard Calling
Station Shifts TX from 50.260 to 50.280
- Continue Normal Contact Procedure

Answering CQ – Offset Method



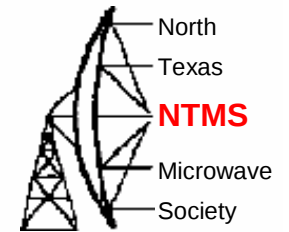
- Answer Station Replies to CQ on Offset Frequency (Above Example would be 50.280)
- Answering Station Sends Both Calls
- CQing Station will Shift His TX Frequency to 50.280 to Continue Normal QSO Procedure

Contact Time



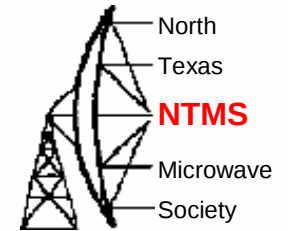
- Contacts Can Take a Few Minutes
- Contacts Can Take Hours
- Patience is Needed for Long Distance QSO
- Common Mistake of New Comer is to Give Up if QSO is Not Quick

My Experience



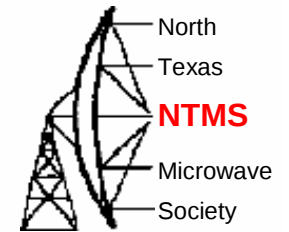
- Have Made Contacts in a Few Minutes
- Have Taken Over an Hour for Contact
- Rox's Availability Major Contributor
- WA5TKU Max 144 MHz DX is 1203 Miles
 - 100 watts – FT-847 – 13 Element Yagi @ 70 feet

DX Records



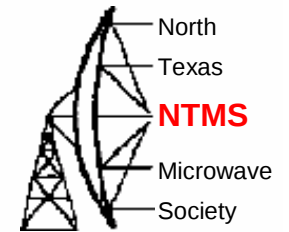
- **Known & verified HSMS Records:**
- 222 MHz AF6O & W7XU 222MHz 1270 mi / 2043 km Aug 12,2007 15:22 Perseids
- 144 MHz K2DRH & N6RMJ 144MHz 1572 mi / 2530 km Aug 13,2009 06:50 Perseids
- 50 MHz VE3CDX & N8JX 50MHz 1627 mi / 2618 km May 16,2008 15:22 eta Aquarids

WA5TKU Station



- 50 MHz
 - FT-920 – 100 watts
 - 5 Element Yagi @ 50 Feet
 - No External Preamp
- 144 MHz
 - FT-847 – Mirage Amp – 100 watts
 - 13 Element Yagi @ 70 Feet
 - Preamp Internal to Mirage Amp
 - Added Fan to Mirage Amp a **MUST!!!**

WA5TKU Station



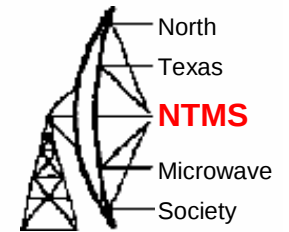
- PC – 1.6 GHz Processor – 2 Gig Ram
- External Sound Card
- Use D4 to Sync PC Clock
- Sound Card Interface Box
- Radio to Sound Card Interface Selector
- Connection to Interface Box Via Back of Radios – Levels Out of Radio Constant

FSK441 DEMO



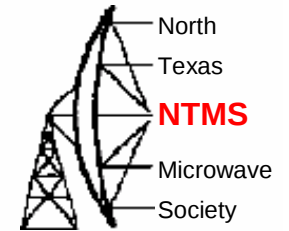
ISCAT

ISCAT



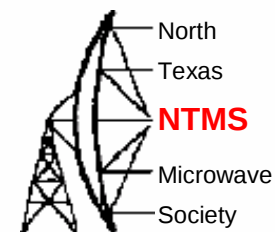
- ISCAT Introduced Summer 2010 in WSJT v8.x
- Results of Testing – ISCAT Replaced JT6M in WSJT v9.x
- Like JT6M Best Used for Tropo & E's
- Improved Signal Decode for Strong Long Burst Signals Like Tropo & E's
- Most North American Stations Now Using ISCAT
- EU Stations Have Not Adopted ISCAT to Date
- May Cause Problem During this Summer E's Season – Keep WSJT 7 on PC

ISCAT



- Options
 - Possible to Run 30 sec or 15 sec Sequences
 - Right Click T/R Period for 15 sec
 - Left Click T/R Period Return to 30 sec

Mode Comparison



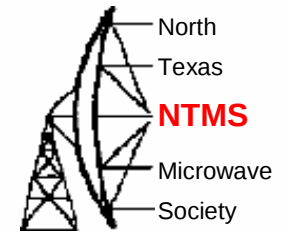
	FSK441	JTMS_2	JT6M	ISCAT_2
T/R period (s)	30	30	30	30
Modulation type	4-FSK	MSK*	44-FSK	41-FSK
Keying rate (baud)	441	1378	21.5	43.1
Characters/s	147	197	14.3	32.3
Bandwidth (Hz)	1764	1378	947	1809

*MSK stands for "minimum shift keying", a technique that allows faster keying while minimizing bandwidth

ISCAT DEMO

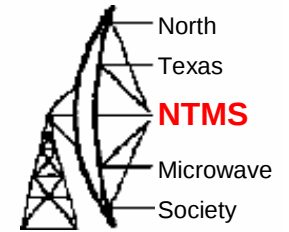


Summary



- Meteor Scatter
 - Showers
 - Random
 - FSK441
- Scatter
 - ISCAT or JT6M
- E Skip
 - ISCAT or JT6M
- Fun to Operate

References



- <http://www.qsl.net/w8wn/hscw/prop/spor-met.html>
- Hines, C.O, Journal of Atmospheric and Terrestrial Physics, 1956, pp.229-232.
- <http://kk7uq.com/>
- <http://www.physics.princeton.edu/pulsar/K1JT/>