



OSCAR “Zero” from a Satellite Operator’s Perspective

- We will talk about... moon bounce
 - Hardware requirements
 - Software requirements
 - JT65, a digital mode optimized for the Earth-Moon-Earth (EME) radio path.
 - Questions and Answers



Why Satellite Operators?

- Natural transition to EME for satellite operators
- Already familiar with Doppler, footprint, AOS, LOS
- Already have yagi antennas on Az/EI rotor
- Already have sideband capable radio
- Already have radio connected to the PC
- Already familiar with using tracking software



Benefits to AMSAT & Satellite Operators

- Better understanding of how to optimize receiver performance
- Better understanding of how to optimize digital coding schemes
- Excellent DX. Virtually every corner of the world can be within the “footprint”
- Excellent pass length: ~12 hours typical
- Utilize existing hardware
- It's “*linear*”



Hardware Requirements

- A typical station capable of operating linear transponder satellites
 - Windows/Mac/*NIX computer
 - SSB VHF/UHF radio
 - Radio to PC interface
 - 100W or more. Less power can be offset by more aluminum.
 - Yagi antennas mounted on an Az/El rotor



Hardware: Antenna

Just about any yagi has been proven to work*!

- ✓ Tape Measure yagi
- ✓ Two element yagi
- ✓ “Arrow” LEO satellite yagi

*provided the antenna on the other end is sufficiently large



EME with Tape Measure and 2 Element Yagi Antennas



G4DVC Tape Measure yagi EME
<http://www.g4dvc.co.uk/dfeme.htm>



DJ7AL 2 element yagi EME
<http://www.dj7al.de/11026.htm>



"Arrow" EME Station





"Arrow" EME Station QSO

WSJT 7 by K1JT

File Setup View Mode Decode Save Band Help

Moon
Az: 129.09
El: 61.31
Dop: 55
Dgrd: -2.4

Mon_110702_195700

FileID	Sync	dB	DT	DF	W		
194500	0	-26	7.4	-183	1	*	
194500	1	-25	2.4	-183	3	*	
194700	0	-28	2.6	-186	1	#	EG6NFB KB8PQ EM79 000 0 10
194900	5	-28		-190	3	RFP	
195100	4	-29		-194	4	73	
195200	10	-18		-183	3	73	
195300	5	-25	2.7	-191	3	*	CQ KB8PQ EM79 0 10
195700	1	0/3					CQ KB8PQ EM79 1 0
195700	2	5/7					

Log QSO Stop Monitor Save Decode Erase Clear Avg Filter Exclude TxDgn

To radio: Lookup
Grid: Add
Az: 73 2033 m

2011 Jul 02
19:58:09

Sync -2 Zap
Clip 0 NB
Tol 25 Freeze
Defaults AFC
Dnec 0.0 Shift 0.0

Tx First
 Rpt
 Ch-Msg
GenClkMsg
Auto is OFF

<input type="checkbox"/>	KB8PQ K0H4LB OMST	<input type="checkbox"/>	TxD
<input type="checkbox"/>	KB8PQ K0H4LB OMST 000	<input type="checkbox"/>	TxD
<input type="checkbox"/>	PO	<input type="checkbox"/>	TxD
<input type="checkbox"/>	RFP	<input type="checkbox"/>	Msg
<input type="checkbox"/>	73	<input type="checkbox"/>	TxD
<input type="checkbox"/>	CQ K0H4LB OMST	<input type="checkbox"/>	TxD



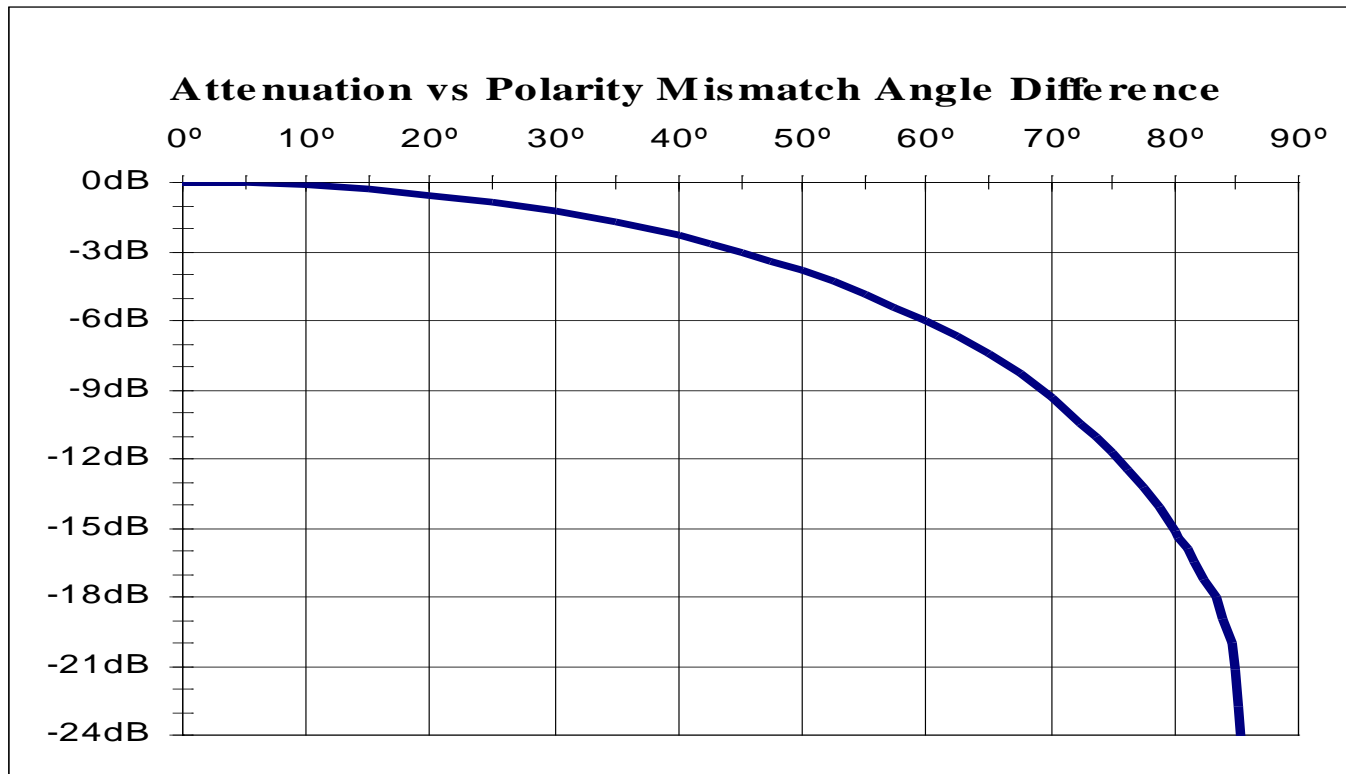
KB8RQ's EME Station





Antenna Polarity

Just like with artificial satellites, polarity matters





Software Requirements

- PC clock synchronization ****IMPORTANT****
- WSJT weak signal suite
 - JT65 is one of many modes contained in the WSJT package
 - FSK
 - “Modern” protocol utilizing compression and error correction



NAT vs. TAT

- Source Coding and Reed Solomon provide a great amount of message dissimilarity.
 - Over a weak or noisy channel, **NAT** and **TAT** can sound very similar, whether by phone or CW, thus easily confused.
 - Once JT65 encoded, the difference between **NAT** and **TAT** becomes the difference between **APPLE** and **ORANGE**. Not easily confused!



Minimalist Satellite QSO

**XE2SAT W6SAT
CM97**

**W6SAT XE2SAT
DK59**

Roger W6SAT



Minimalist JT65 EME QSO

CQ W6SAT CM97

**W6SAT XE2SAT
DK59**

**XE2SAT W6SAT
OOO**

RO

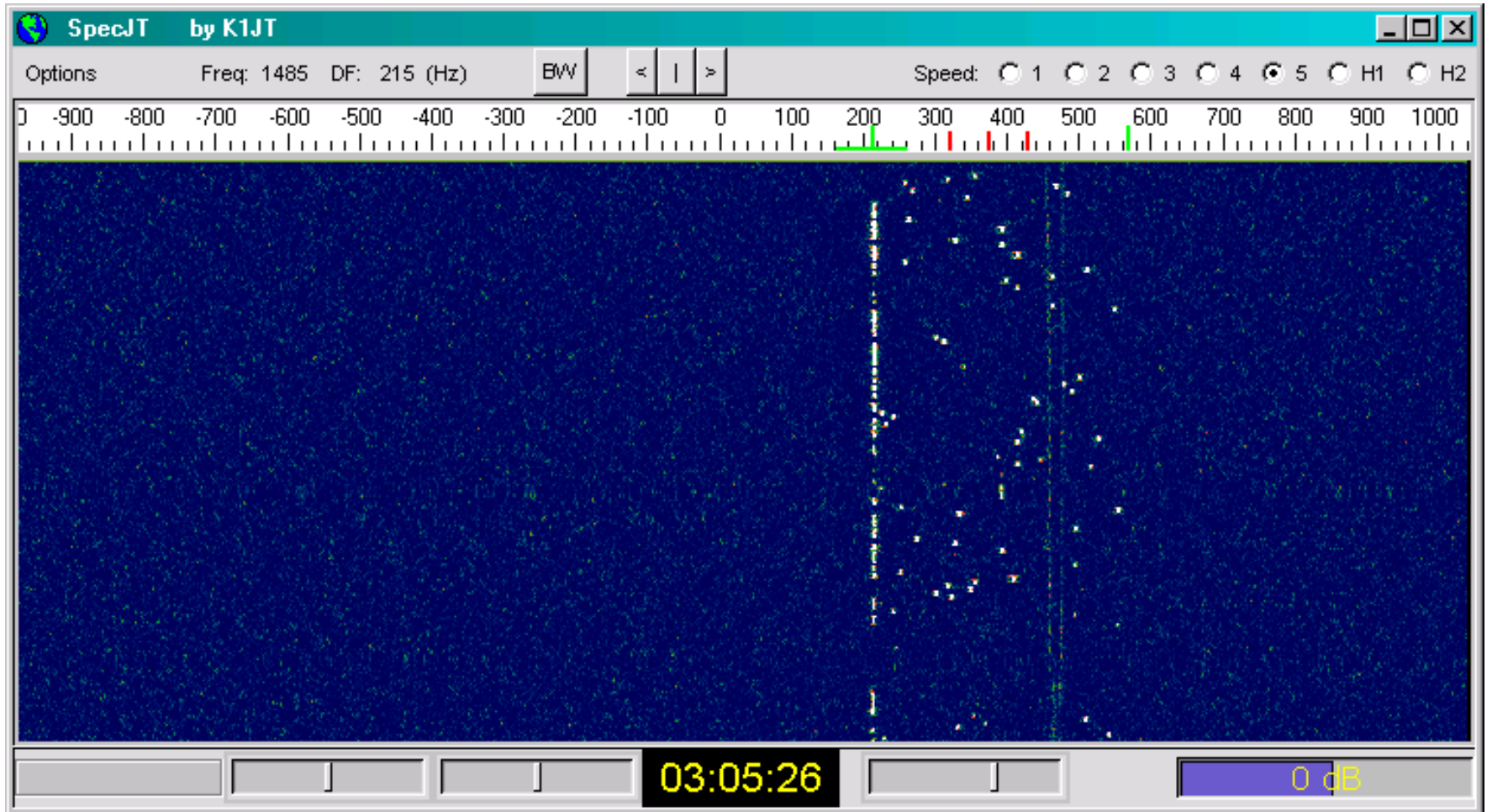
RRR

73

CQ W6SAT CM97



JT65 Signal in the SpecJT Window





WSJT Main Window

WSJT 9.02 by K1JT

File Setup View Mode Decode Save Band Help

Moon
 Az: 232.27
 El: 18.79
 Dop: -113
 Dgrd: -2.0

47.2 Time (s) Mon_110929_003100

FileID	Sync	dB	DT	DF	VV					
000600	0	-21	4.0	113	3	#	W6EME	K5SO	DM66	0 ? 0 4
000800	0	-23	4.3	167	5	*				
012100	2	-24	2.3	-22	4	#	K1JT	EI4DQ	I051	000 1 0
012300	10	-25		-22	3	R0 ?				
163600	2	-26	2.5	221	4	#	K1JT	IK1UWL	JN33	000 1 0
163800	0	-22	6.5	568	27	#				
005600	5	-16	2.9	215	0	*	CQ	RU1AA	K048	1 0

Log QSO

Stop

Monitor

Decode

Erase

Clear Avg

Include

Exclude

TxStp

To radio:

Grid:

Az: 14 5475 mi

2011 Sep 29
 00:32:32

Sync -1 Zap

Tol 50 AFC

Freeze

Tx First

RU1AA W6EME CM97	<input type="radio"/>	Tx1
RU1AA W6EME CM97 000	<input checked="" type="radio"/>	Tx2
RO	<input type="radio"/>	Tx3
RRR	<input type="radio"/>	Tx4
73	<input type="radio"/>	Tx5
CQ W6EME CM97	<input type="radio"/>	Tx6

1.0001 1.0069

JT65B

Freeze DF: 115

Rx noise: 0 dB

T/R Period: 60 s

Receiving



JT65 Advantages

- Unparalleled sensitivity and resilience
- Can multitask while operating
 - Be productive while you operate!
 - Email
 - Surf the web
 - Talk on the phone
 - Work
- Human element involved. Operator skill makes a difference



JT65 Disadvantages

- Slow data rate
 - 13 characters of random text or 2 calls + report/grid in 48 sec
- PC required
- Accurate time sync required (Internet or GPS based)
- SDR (required?) for random contacts
- Human element involved. Operator skill makes a difference



JT65 Distinctions

- Macro driven. Contacts made with the mouse, not keyboard
- Human skills required. Operator must analyze and validate the computer's output.
- 10dB – 15dB better performance than the next best mode, CW



What DX is out there?

Callsign	Grid	Callsign	Grid	Callsign	Grid
F6FHP	IN94	F6HVK	JN27	OK1CU	JO80
DF7KF	JO30	F8DO	JN26	PA0JMV	JO21
DK0KK	JO30	I2FAK	JN45	RK3FG	KO86
DK3WG	JO72	K1OR	FN42	RU1AA	KP40
DL8GP	JN39	K6MYC	DM07	S52LM	JN65
DL8YHR	JO41	K9MRI	EN70	SM5DIC	JO89
DL9MS	JO54	KB8RQ	EM79	SM7GVF	JO77
EA2AGZ	IN91	N9XG	EN60	UA3PTW	KO93

11.4dBd 9 element yagi + 300W

1.79dBnf/14.25dBG LNA



JT65 Operating tips

- Read my paper
 - Read all of its references
 - Read the WSJT manual, complete its JT65 tutorial
- Sync your clock. BktTimeSync, Meinberg, NTP, etc
- Assess your noise floor
 - ~15dBG LNA should not cause your S meter to move
 - “Foxhunt” noise sources in your house
- Practice on HF
 - But watch out, extremely poor operating is prevalent on HF
“Human element involved. Operator skill makes a difference”
- Re-Read my paper



Final thoughts

- This talk barely scratched the surface
- Reading and Re-reading my paper will scratch the surface deeper
- Don't be alarmed if you find out you're "deaf". You never needed "ears" for what you were previously doing
- Improving your station's capacity to operate OSCAR "Zero" substantially improves its capacity to operate other satellites