Telefon: +49 7738 939 1882
Telefax: +49 7738 939 1861
Email: info@jultec.de
Web: www.jultec.de

New tuning format "JESS" (JULTEC Enhanced Stacking System) for CSS systems

Purpose:
The purpose of defining and introducing a new tuning format is to solve problems and limitations with the existing tuning format that is defined in EN50494.
EN50494 allows to feed 8 tuners via one coaxcable, although there is already hardware for 12 tuners available. The maximum possible number of userbands within the usable Sat-IF frequency range separated with optimal filters is 30 (UB spacing 40MHz). JESS allows to address 32 userbands.
For tighter output frequency allocation the filters have to become more accurate. Therefore the tuning stepsize of 4MHz is not frequency-agile enough. JESS allows to tune exactly per MHz.
To prevent any needs for look-up-tables etc., the Sat-IF frequency, the tuner in the set top box would tune to when a LNB is connected directly, is transmitted.
The limitation of EN50494 to address two satellite systems only prevented the use of channel stacking systems in many apartment blocks so far. JESS has enough capacity to address 64 satellites through the single downlead cable.
The new data format still bases on a serial bursted 22kHz tone data transmission. The advantage is compatibility with existing platforms and installations. Satellite receivers and stacking devices can be upgraded to JESS by just a firmware update. Hardware modification may be required for bi-directional use of JESS.

Downwards compatibility:
All stacking devices according to JESS must be downwards-compatible with the message format according to EN50494. This means that the functions of the new tuning format must be added on top of the existing EN50494 functionality. The amount of functions may be reduced in downward-compatible mode (e.g. EN50494 receiver can only control 2 satellite systems while stacker hardware may provide 4 satellite systems). New format and EN50494 can be mixed and work parallel (e.g. UB1 uses EN50494 tuning, UB2 uses "new" tuning). Functions such as beacon tones known from EN50494 are still supported.

Data format:
Data format bases on 22kHz PWK modulation with one parity bit per byte such as used in DiSEqC, EN50494 and others. For clarity, the parity bit is never shown in this document, but has to be generated and transmitted according to DiSEqC Spec.

Message structure:
As no parallel operation with other controls then remote tuning is required, there is no reason to keep the DiSEqC message structure with address, command etc. for JESS. This way JESS-tuning is faster compared with EN50494 and the bus busy time is minimised.
JESS messages always start with framing "7Xh". Devices designed for other message structures will ignore the new commands.

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Command overview:
70 -> (from receiver) tuning
71 -> (from receiver) tuning (PIN protected)
74 -> (from headend) reply "OK", data might follow
7A -> (from receiver) ask headend for available UBs
7B -> (from receiver) ask for UBs actually being PIN protected
7C -> (from receiver) ask for UBs currently being in use
7D -> (from receiver) ask for UB centre frequency of requested UB
7E -> (from receiver) ask for available polarity switches

Command 70:
The tuning command 70h consists of four bytes in total

70h	Data 1	Data 2	Data 3

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB [4:0]					T [10:8]		

Data 2 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
T [7:0]							

Data 3 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
"uncommitted switches"				"committed switches"			

70h is the tuning command
UB contains the userband-ID (1..32). Bit .3 is LSB
T contains the frequency as a 11 bit value, Data 2 Bit .0 is LSB. It is the frequency, the tuner of the receiver would tune to when connected to a standard LNB, minus 100MHz. The maximum possible tuning frequency with this format is 2147MHz.
There are special "frequencies" defined:
"0" turns off the UB
"1" switches on a tone at the centre of the UB
"2" switches on a tone at the centre plus 20MHz
"3" switches on all tone beacons.
IMPORTANT NOTE: Frequency “3” is for test purposes only, must not be implemented into any receivers! Must not be used for userband-scan!
"4" to "9" reserved (future use possible)
("10" is the first tuning value and tunes to the frequency 110MHz)
"uncommitted switches" and "committed switches" are the bits known from DiSEqC specification. Bit .0 is "band", Bit .1 is "polarity"...

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Command 71:
Optional command for tuning with PIN code protection
Tuning command 71 is similar to 70, but a PIN code is added. The specific userband is usable for accesses without PIN until a tuning command with valid PIN is received. It then becomes "locked" for accesses without or with wrong PIN code (until hardware power down or power down message with command 71 and correct PIN code).

71h	Data 1	Data 2	Data 3	Data 4

Data 4 contains the PIN code known from EN50494 extension for PIN code

74:
Reply from headend (described above/below)

Command 7A:
This is a one-byte command to ease receiver installation.

7Ah

When the command 7A is sent, the headend replies the available userbands, bit-coded.

74h	Data 1	Data 2	Data 3	Data 4

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_32	UB_31	UB_30	UB_29	UB_28	UB_27	UB_26	UB_25

Data 2 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_24	UB_23	UB_22	UB_21	UB_20	UB_19	UB_18	UB_17

Data 3 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_16	UB_15	UB_14	UB_13	UB_12	UB_11	UB_10	UB_9

Data 4 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_8	UB_7	UB_6	UB_5	UB_4	UB_3	UB_2	UB_1

For example a CSS system with 12 userbands replies "74 00 00 0F FF".
IMPORTANT NOTE: In some installations only single UBs or blocks of UBs may be available that do not start at “UB_1”. Receivers using command “7A” must support these replies.

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Command 7B:
This is a one-byte command to ease receiver installation.

7Bh

When the command 7B is sent, the headend replies the userbands currently being PIN-protected. UBs being PIN-protected by EN50494-commands must be reported here, too.

74h	Data 1	Data 2	Data 3	Data 4

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_32	UB_31	UB_30	UB_29	UB_28	UB_27	UB_26	UB_25

Data 2 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_24	UB_23	UB_22	UB_21	UB_20	UB_19	UB_18	UB_17

Data 3 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_16	UB_15	UB_14	UB_13	UB_12	UB_11	UB_10	UB_9

Data 4 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_8	UB_7	UB_6	UB_5	UB_4	UB_3	UB_2	UB_1

If as an example userbands with ID 3 and ID 5 are currently PIN protected, the reply would be "74 00 00 00 28".

Command 7C:
This is a one-byte command to ease receiver installation.

7Ch

When the command 7C is sent, the headend replies the userbands currently in use, bit-coded. "In use" means active frequency conversion (last JESS tuning command had frequency "10" or higher or adequate EN50494 tuning command). A tone beacon (frequency "1", "2" or "3") is "not in use".

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74h	Data 1	Data 2	Data 3	Data 4

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_32	UB_31	UB_30	UB_29	UB_28	UB_27	UB_26	UB_25

Data 2 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_24	UB_23	UB_22	UB_21	UB_20	UB_19	UB_18	UB_17

Data 3 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_16	UB_15	UB_14	UB_13	UB_12	UB_11	UB_10	UB_9

Data 4 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB_8	UB_7	UB_6	UB_5	UB_4	UB_3	UB_2	UB_1

Command 7D:
To ease installation, the receiver can request the centre frequency of a specific userband.

7Dh	Data 1

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB [4:0]					Set to "0"		

The headend replies in a format similar to the tuning command.

74h	Data 1	Data 2

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB [4:0]					T [10:8]		

Data 2 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
T [7:0]							

The headend repeats the UB-ID and sends the UB frequency as a 10 bit value, where 100MHz must be added. If the userband is not available, the frequency is "0".

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Command 7E:
The receiver can request the available polarity/satellite control switches.

7Eh	Data 1

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB [4:0]					Set to "0"		

The headend replies:

74h	Data 1	Data 2

Data 1 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
UB [4:0]					Set to "0"		

Data 2 format:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
"uncommitted switches"				"committed switches"			

See command "70" for further bit description.

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Implementation:

Data generation (receiver):
Same timing and voltage levels are used (14V->18V transition, tuning message, 18V->14V transition) as in EN50494. There must be only one message per 18V duration.
Additionally to EN50494 there is more restriction in JESS regarding bus occupancy for new receiver designs. Every receiver configured to JESS must NOT:

1 send out any other commands then defined here (no EN50494 commands, no DiSEqC switching commands, no ToneBurst, no continuous tone)
2 send out >15V for longer then 100ms during start-up of receiver
3 send out 22kHz tone for longer then 100ms during start-up of receiver
4 go into standby/switch off LNB supply without sending a power down command and ensure that UB is really deactivated (not applicable when cutting mains power).

To be able to use bi-directional functions of JESS, receivers must be equipped with DiSEqC 2.0 "master" bus modem hardware. When requesting a reply, the satellite receiver must hold the voltage at 18V until the reply from the headend is received. There is a timeout of 50ms defined. If no valid reply framing is received within this period, the voltage must go back to 14V.
The headend must start reply between 15ms and 25ms after the command and only reply when the voltage is still at 18V.

User interface (receiver):
To simplify installation and prevent misconfiguration, the satellite receiver menus should somehow be standardised:

- Mode selection: there should be a separate menu point to select either direct LNB connection, EN50494 mode or JESS tuning format. The mode selection should not be included in the LNB type menu as channel stacking only provides an independent path to the LNB and is independent from the LNB type really used.
- A channel stacking menu should be available when channel stacking (either EN50494 or new format) is selected. Here userband-ID and userband-frequency must be enterable. To prevent user misunderstanding, the userband-ID must be counted from "1" to "32" in the user-interface. Note that in JESS there is no "SCR" counting.
- Satellite input allocation can be used from the "satellite allocation" menus that are already used for DiSEqC, DiSEqC committed and uncommitted switches bits known from multiswitch applications can be matched into JESS directly. Remember not to send out any DiSEqC commands for multiswitches in either EN50494 or JESS mode.
- Automatic or semi-automatic installation is possible. If implemented, the satellite receiver must still allow to enter UB-ID and UB-frequency manually.

Collision handling (receiver):
Remote tuning is a multi-master system, therefore data collisions may happen. Due to the hardware of the distribution network (diode isolated splitters) no easy and safe collision prevention is possible. The receivers can only "blindly" send out the tuning commands and have to check whether the tuning command was processed or not. The method how to detect non-successful tuning is described in EN50494.
In case of any non successful tuning command, the receiver repeats the command in pseudo-statistic intervals. Timeslots of 1.4 seconds are repeated, within these slots the repeat should be started by random. The commands are sent out endlessly until the correct signal is received. This repeat function must also be started if no signal is received at power-up of receiver.

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Note for channel search: For channel search the command should not be sent more then 5 times. After that, a "not successful" message should be displayed.

Power issues:
Channel stackers might be fully receiver-powered. Startup timing as described in DiSEqC Bus Spec might not be implementable due to to soft-start, switch-mode converters and large buffer-capacitors in CSS devices. Receivers must still successfully initialize CSS units even when start-tup is longer then 100ms. Maximum allowed start-up time is 1 second.
CSS units must ensure that the continuous receiver load current must not exceed 350mA under normal operation. Over current protection circuits in receivers must allow higher peak currents during start-up. In case of over-current detection, receivers must automatically retry to switch on LNB power again.
CSS units must load each CSS bus with a minimum of 20mA under all circumstances to "open" all diode paths in the distribution network and allow reliable transmission of 22kHz control data.

Bi-directional communication:
The receiver may "ask" the channel stacker for amount of available functions and UB-specific data. Different to DiSEqC specification, the CSS unit must start a reply between 15ms and 25ms after received message. The CSS unit must only answer when the bus voltage is still >15V.
Bi-directional support must be implemented in all channel stacking devices. Implementation for receivers is optional.

Emulation (CSS unit):
The new tuning format only describes a method how to move the RF tuning from receiver´s tuner to the CSS unit to allow individual signal feed to multiple tuners via one common down-lead cable. CSS devices may include more functionality then just the channel stacker (e.g. Multiswitch function, LNB function, optical converter function).
LNBs may use a wide-band hardware architecture with one LO instead of a usual Univer-sal-LNB architecture with two LOs. Independent from the real architecture all JESS-LNBs must behave as Universal-LNBs (Universal Ku or Universal Ka [T.B.D.]).