DTV PREAMP SIGNAL OVERLOAD CALCULATOR **[Presuming Line-Of-Sight Propagation]** **13-Mar-12**
holl_ands
Rev M

INPUT VALUES: [Select station with strongest signal] **Calculated UHF Frequency**

24		UHF Channel (A-KVCR example shown)
1320	kW	Transmitter ERP (towards receiver), where Pt (dbm) = 10 log ERP (kW) + 60
0.0	dB	Enter 0.0 dB if Analog or 7.0 dB if Digital to convert from average to peak power.
0.0	dB	Add'l Loss in excess of Line-of-Sight, due to Terrain Diffraction, Clutter, Attic/Indoor Loss, etc.
-6.0	dBd	Rcv Antenna Gain at Channel Freq **[In Antenna Backlobe]**
2.0	dB	Rcv System Loss (Balun + Cable between Antenna and Preamp)
2.7	dB	Downlead Loss (Preamp to HDTV, incl. Coax + RF Splitters)
5.4	mi	Distance

533 MHz Center Freq, Fc = 473 + 6 * (Chan - 14)

-20.4 dBm **Input Sip**

Compare to Max Sip and Sip (SFDR) calculated below.

WG HDP-269	WG 4700	WG 4800	CM Spartan	CM Titan	BT CMA-Uc	BT SCMA-Ub		
12.0	19.0	28.0	23.0	26.0	20.0	24.0	dB	Preamp Gain Specs
2.7	2.7	2.7	2.7	2.7	2.7	2.7	dB	Downlead + Splitter Loss
-11.1	-4.1	4.9	-0.1	2.9	-3.1	0.9	dBm	**Sih = HDTV/STB Input [Keep below -10 dBm] [Best below -15 dBm]**

Additional attenuation on HDTV input may be needed to prevent overload.

MINIMUM RECOMMENDED DISTANCE [For Above Transmitter and Receive Parameters]

Distance	Input Sip	WG HDP-269	WG 4700	WG 4800	CM Spartan	CM Titan	BT CMA-Uc	BT SCMA-Ub		HDTV/STB Input:
2.5 mi	-13.7 dBm	-4.4	2.6	11.6	6.6	9.6	3.6	7.6	dBm	Sih
5.0 mi	-19.7 dBm	-10.4	-3.4	5.6	0.6	3.6	-2.4	1.6	dBm	Sih
10.0 mi	-25.8 dBm	-16.5	-9.5	-0.5	-5.5	-2.5	-8.5	-4.5	dBm	Sih
15.0 mi	-29.3 dBm	-20.0	-13.0	-4.0	-9.0	-6.0	-12.0	-8.0	dBm	Sih
20.0 mi	-31.8 dBm	-22.5	-15.5	-6.5	-11.5	-8.5	-14.5	-10.5	dBm	Sih
25.0 mi	-33.7 dBm	-24.4	-17.4	-8.4	-13.4	-10.4	-16.4	-12.4	dBm	Sih
30.0 mi	-35.3 dBm	-26.0	-19.0	-10.0	-15.0	-12.0	-18.0	-14.0	dBm	Sih
35.0 mi	-36.6 dBm	-27.3	-20.3	-11.3	-16.3	-13.3	-19.3	-15.3	dBm	Sih
40.0 mi	-37.8 dBm	-28.5	-21.5	-12.5	-17.5	-14.5	-20.5	-16.5	dBm	Sih

SPURIOUS FREE DYNAMIC RANGE (SFDR) CALCULATION: [Based on Manufacturer Specs and 3rd Order IMD]

	WG HDP-269	WG 4700	WG 4800	CM Spartan	CM Titan	BT CMA-Uc	BT SCMA-Ub			
RED=W-G Spec Values:	**103.5**	**99.4**	**89.5**	81.0	79.0	**86.0**	**95.0**	dBuV	**Max Siv (5 sigs)**	NOTE:
Convert dBuV to dBmV	**43.5**	**39.4**	**29.5**	21.0	19.0	**26.0**	**35.0**	dBmV	**Max Siv (5 sigs)**	W-G and B-T calculate
Convert Siv to Sip:	**-5.2**	**-9.4**	**-19.2**	**-27.8**	**-29.8**	**-22.8**	**-13.8**	dBm	**Max Sip (5 sigs)**	down in spread sheet,
Deratings:	**-4.2**	**-8.4**	**-18.2**	**-26.8**	**-28.8**	**-21.8**	**-12.8**	dBm	**Max Sip (4 sigs)**	whereas C-M calculates
Compare Input Sip	**-2.7**	**-6.9**	**-16.7**	**-25.3**	**-27.3**	**-20.3**	**-11.3**	dBm	**Max Sip (3 sigs)**	up from Max Sov Spec.
(below) to Max Sip ==>	**0.8**	**-3.4**	**-13.2**	**-21.8**	**-23.8**	**-16.8**	**-7.8**	dBm	**Max Sip (2 sigs)**	
RED=Spec Values:	**12.0**	**19.0**	**28.0**	**23.0**	**26.0**	**20.0**	**24.0**	dB	**Gp = Preamp Gain**	
RED=Spec Values:	**3.0**	**2.9**	**2.7**	**2.2**	**2.0**	**3.0**	**2.5**	dB	**Noise Figure**	
				Derated 6 dB:						
Max Siv - 60 + Gp:	55.5	58.4	57.5	**44.0**	**45.0**	46.0	59.0	dBmV	**Max Sov (5 sigs)**	
FYI: Max Sov + 48.75:	**6.8**	**9.6**	**8.8**	**-4.8**	**-3.8**	**-2.8**	**10.3**	dBm	**Max Sop (5 sigs)**	
RED=C-M Spec Values:	61.5	64.4	63.5	**50.0**	**51.0**	52.0	65.0	dBmV	**Max Sov (2 sigs)**	**RED=C-M Max Sov**
FYI: Max Sov + 48.75:	**12.8**	**15.6**	**14.8**	**1.3**	**2.3**	**3.3**	**16.3**	dBm	**Max Sop (2 sigs)**	
IMD = Max Sip - 46 dB:	-45.2	-49.4	-59.2	-67.8	-69.8	-62.8	-53.8	dBm	IMD Levels (2 sigs)	
Delta to -106 dBm:	60.8	56.6	46.8	38.3	36.3	43.3	52.3	dB	IMD - Thermal Noise	
Divide by 3:	20.3	18.9	15.6	12.8	12.1	14.4	17.4	dB	Sip Backoff (2 sigs)	
Max Sip - Sip Backoff:	**-19.5**	**-22.3**	**-28.8**	**-34.5**	**-35.8**	**-31.2**	**-25.2**	dBm	**Sip (SFDR), 2 channels**	
Sip (SFDR) - 106 + 15.2	**71.3**	**68.5**	**62.0**	**56.3**	**55.0**	**59.6**	**65.6**	dB	**Dynamic Range**	
Thermal Noise + 15.2 dB:	-90.8	-90.8	-90.8	-90.8	-90.8	-90.8	-90.8	dBm	Weakest Signal	

DERATING SiP (SFDR) FOR OTHER THAN 2 STRONG CHANNELS

								DERATING:
-23.1	**-25.9**	**-32.4**	**-38.1**	**-39.4**	**-34.8**	**-28.8**	dBm	**3 channels (- 3.6 dB)**
-24.5	**-27.3**	**-33.8**	**-39.5**	**-40.8**	**-36.2**	**-30.2**	dBm	**4 channels (- 5 dB)**
-25.5	**-28.3**	**-34.8**	**-40.5**	**-41.8**	**-37.2**	**-31.2**	dBm	**5 channels (- 6 dB)**
-26.5	**-29.3**	**-35.8**	**-41.5**	**-42.8**	**-38.2**	**-32.2**	dBm	**6 channels (- 7 dB)**

-27.5	-30.3	-36.8	-42.5	-43.8	-39.2	-33.2	dBm	**8 channels (- 8 dB)**

For max dynamic range, Sip should be no higher than "Sip (SFDR)"

CHANNEL MASTER OVERLOAD SPECS: [FOR OUTPUT]

Sov = 51 dBmV for Channel Master 26 dB Titan series: CM7775 and CM7777

Sov = 50 dBmV for Channel Master 23 dB Spartan series:

0064DSB, 3041DSB, 0264DSB, 0068DSB, 0065DSB & 0265DSB

C-M: "UHF output capability for 2 input channels at -46 dB cross-modulation. Derate by 5 dB for 4" "(strong?) input channels and 8 dB for 8 (strong?) input channels."

WINEGARD OVERLOAD SPECS: [FOR INPUT]

Siv = 30,000 uV (89.5 dBuV) for Winegard 28 dB Gain Preamps: AP-4800, 8275, 8283, 8780, 8783

Siv = 93,000 uV (99.4 dBuV) for 19 dB Gain Preamps: AP-2870, 2880, 4700, 8700, 8703, 8733, 8800, 8803, 8833

Siv = 150,000 uV (103.5 dBuV) for Winegard 12 dB Gain HDP-269 Preamp [W-G specs used to say 350,000 uV)

W-G: "Outputs (actually inputs) stated for 7 VHF and 5 UHF channels at -46 dB (output) cross mod'l'n."

BLONDER-TONGUE OVERLOAD SPECS: [FOR INPUT]

Siv = 26 dBmV for Blonder Tongue 20 dB CMA-U

Siv = 35 dBmV for Blonder Tongue 24 dB SCMA-Ub

POWER BACKOFF CALCULATIONS:

Number Of Equal Pwr Carriers	Peak Pwr	Avg Pwr	Pk/Avg	C-M Specs	Backoffs wrt 2 carr.	W-G Spec	Backoffs wrt 5 carr.	Suggested Backoffs
1	1	0.707	3.0 dB		-6.0 dB		-14.0 dB	-6 dB
2	4	1.414	9.0 dB	0 dB	0.0 dB		-8.0 dB	0 dB
3	9	2.121	12.6 dB		3.6 dB		-4.4 dB	3.6 dB
4	16	2.828	15.1 dB	5 dB	6.1 dB		-1.9 dB	5 dB
5	25	3.535	17.0 dB		8.0 dB	0 dB	0.0 dB	6 dB
6	36	4.242	18.6 dB		9.6 dB		1.6 dB	7 dB
8	64	5.656	21.1 dB	8 dB	12.1 dB		4.1 dB	8 dB

EQUATIONS:

Lf (dB) = 36.58 + 20 log(MHz) + 20 log (miles) Free Space Loss [Use 32.44 if km]

Sip (dBm) = Pt (dBm) - (Free Space Loss) - (Add'l Loss) + (Ant. Gain) - (Rcv Loss)

Sip (dBm) = Siv (dBmV) - 48.75

Siv (dBuV) = Siv (dBmV) + 60

Siv (dBmV) = Sip (dBm) + 48.75
Sop (dBm) = Sip (dBm) + PreAmp Gain (dB)

DISCUSSION:

Max Sip (Maximum input signal level to Preamp) is calculated based on manufacturer's specs.
C-M specs are derated 6 dB to match W-G's specs for 5 strong UHF input signals.
The maximum Spurious Free Dynamic Range (SFDR) corresponds to when the input level is reduced until the InterMod product levels are no higher than a Preamp's -106 dBm Thermal Noise level.
Since Third Order InterMod product levels are reduced by 3 dB for each 1 dB reduction in input level, the "Sip for SFDR" can be found by calculating the IM Levels at the overload spec point, and then determining how much these are above the -106 dBm noise level. Dividing by three will yield the amount of input "Backoff" from Max Sip spec point which will push IM noise to Thermal noise floor.

Be sure to include loss in Downlead and RF Splitters when calculating max input to HDTV/STB.

An RF attenuator may need to be inserted between Preamp and HDTV/STB. (e.g R-S 15-678)

Analog NTSC power is always measured with a PEAK power meter, whereas DTV is AVERAGE
Since infrequent peaks cause overload errors, add 7 dB to DTV average power level.

OTHER COMMENTS:

All calculations are based on specs found on manufacturer's websites.
Whether the receive sensitivity is degraded on a particular channel will depend not only on the intermodulation characteristics of a particular Preamp, but also on the relative signal strengths and frequency allocations of the channels.
HDTV and STB maximum input specs are very important, but are usually never disclosed.

REFERENCES:

Canadian Research Center (CRC) tests on **PROTOTYPE** ATSC Receivers:
http://www.crc.ca/en/html/crc/home/research/broadcast/rtnt
FCC Office of Engineering Technology tests on STBs/HDTVs available in 2005 & 2006:
FCC_OET TR-05-1017 - Lab Tests of ATSC 8-VSB Reception Performance - Nov2005
FCC_OET 07-TR-1003 - DTV Interference Rejection Thresholds - 221 pgs 30Mar2007

Additional info: http://www.odyseus.nildram.co.uk/Systems_And_Devices_Files/Linearity.pdf
http://www.avsforum.com/avs-vb/showthread.php?p=6163454

This File posted on AVSForum, with further explanations:
http://www.avsforum.com/avs-vb/showpost.php?p=15005797&postcount=8148
& Examples: http://www.avsforum.com/avs-vb/showthread.php?p=6206737
http://www.avsforum.com/avs-vb/showthread.php?p=6208266
http://www.avsforum.com/avs-vb/showthread.php?p=6290253

DTV PREAMP SIGNAL OVERLOAD CALCULATOR **[Presuming Line-Of-Sight Propagation]** **14-Sep-11**
holl_ands
Rev L

CHAN

INPUT VALUES: [Select station with strongest signal]

198 MHz VHF Center Frequency
100 kW Transmitter ERP (towards receiver), where Pt (dbm) = 10 log ERP (kW) + 60
0.0 dB Enter 0.0 dB if Analog or 7.0 dB if Digital to convert from average to peak power.
0.0 dB Add'l Loss in excess of Line-of-Sight, due to Terrain Diffraction, Clutter, Attic/Indoor Loss, etc.
-6.0 dBd Rcv Antenna Gain at Channel Freq **[In Antenna Backlobe]**
2.0 dB Rcv System Loss (Balun + Cable between Antenna and Preamp)
2.7 dB Downlead Loss (Preamp to HDTV, incl. Coax + RF Splitters)
5.4 mi Distance

WINE

-23.0 dBm **Input Sip**

Compare to Max Sip and Sip (SFDR) calculated below.

If not one of these Preamps, pick closest and adjust for differences.

	WG HDP-269	CM CM7778	WG AP2870	CM CM7777	WG AP2880		
Preamp Gain Specs	12.0	16.0	17.0	23.0	29.0	dB	
Downlead + Splitter Loss	2.7	2.7	2.7	2.7	2.7	dB	
Sih = HDTV/STB Input [Keep below -10 dBm] [Best below -15 dBm]	-13.7	-9.7	-8.7	-2.7	3.3	dBm	

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Additional attenuation on HDTV input may be needed to prevent overload.

MINIMUM RECOMMENDED DISTANCE [For Above Transmitter and Receive Parameters]

Distance	Input Sip	WG HDP-269	CM CM7778	WG AP2870	CM CM7777	WG AP2880		HDTV/STB Input:
2.5 mi	-16.3 dBm	-7.0	-2.0	10.0	-3.0	4.0	dBm	Sih
5.0 mi	-22.3 dBm	-13.0	-8.0	4.0	-9.0	-2.0	dBm	Sih
10.0 mi	-28.4 dBm	-19.1	-14.1	-2.1	-15.1	-8.1	dBm	Sih
15.0 mi	-31.9 dBm	-22.6	-17.6	-5.6	-18.6	-11.6	dBm	Sih
20.0 mi	-34.4 dBm	-25.1	-20.1	-8.1	-21.1	-14.1	dBm	Sih
25.0 mi	-36.3 dBm	-27.0	-22.0	-10.0	-23.0	-16.0	dBm	Sih
30.0 mi	-37.9 dBm	-28.6	-23.6	-11.6	-24.6	-17.6	dBm	Sih
35.0 mi	-39.2 dBm	-29.9	-24.9	-12.9	-25.9	-18.9	dBm	Sih
40.0 mi	-40.4 dBm	-31.1	-26.1	-14.1	-27.1	-20.1	dBm	Sih

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SPURIOUS FREE DYNAMIC RANGE (SFDR) CALCULATION: **[Based on Manufacturer Specs and 3rd Order IMD]** **DISC**

	WG HDP-269	CM CM7778	WG AP2870	CM CM7777	WG AP2880			NOTE:
RED=W-G Spec Values:	**103.5**	94.0	**100.8**	88.0	**89.2**	dBuV	**Max Siv (5 sigs)**	W-G and B-T calculate
Convert dBuV to dBmV	**43.5**	34.0	**40.8**	28.0	**29.2**	dBmV	**Max Siv (5 sigs)**	down in spread sheet,
Convert Siv to Sip:	**-5.2**	**-14.8**	**-7.9**	**-20.8**	**-19.5**	dBm	**Max Sip (5 sigs)**	whereas C-M calculates
Deratings:	**-4.2**	**-13.8**	**-6.9**	**-19.8**	**-18.5**	dBm	**Max Sip (4 sigs)**	up from Max Sov Spec.
Compare Input Sip	**-2.7**	**-12.3**	**-5.4**	**-18.3**	**-17.0**	dBm	**Max Sip (3 sigs)**	
(below) to Max Sip ==>	**0.8**	**-8.8**	**-1.9**	**-14.8**	**-13.5**	dBm	**Max Sip (2 sigs)**	
RED=Spec Values:	**12.0**	**16.0**	**17.0**	**23.0**	**29.0**	dB	**Gp = Preamp Gain**	
RED=Spec Values:	**2.7**	**3.0**	**2.9**	**2.8**	**2.9**	dB	**Noise Figure**	
Max Siv - 60 + Gp:	55.5	50.0	57.8	51.0	58.2	dBmV	**Max Sov (5 sigs)**	
FYI: Max Sov + 48.75:	**6.8**	**1.3**	**9.1**	**2.3**	**9.5**	dBm	**Max Sop (5 sigs)**	
RED=C-M Spec Values:	61.5	**56.0**	63.8	**57.0**	64.2	dBmV	**Max Sov (2 sigs)**	**RED=C-M Sov Specs**
FYI: Max Sov + 48.75:	**12.8**	**7.3**	**15.1**	**8.3**	**15.5**	dBm	**Max Sop (2 sigs)**	
								OTHE
IMD = Max Sip - 46 dB:	-45.2	-54.8	-47.9	-60.8	-59.5	dBm	IMD Levels (2 sigs)	
Delta to -106 dBm:	60.8	51.3	58.1	45.3	46.5	dB	IMD - Thermal Noise	
Divide by 3:	20.3	17.1	19.4	15.1	15.5	dB	Sip Backoff (2 sigs)	
Max Sip - Sip Backoff:	**-19.5**	**-25.8**	**-21.3**	**-29.8**	**-29.0**	dBm	**Sip (SFDR), 2 channels**	
Sip (SFDR) - 106 + 15.2	**71.3**	**65.0**	**69.5**	**61.0**	**61.8**	dB	**Dynamic Range**	
Thermal Noise + 15.2 dB:	-90.8	-90.8	-90.8	-90.8	-90.8	dBm	Weakest Signal	
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DERATING SiP (SFDR) FOR OTHER THAN 2 STRONG CHANNELS

						DERATING:
-23.1	**-29.4**	**-24.9**	**-33.4**	**-32.6**	dBm	**3 channels (- 3.6 dB)**
-24.5	**-30.8**	**-26.3**	**-34.8**	**-34.0**	dBm	**4 channels (- 5 dB)**
-25.5	**-31.8**	**-27.3**	**-35.8**	**-35.0**	dBm	**5 channels (- 6 dB)**
-26.5	**-32.8**	**-28.3**	**-36.8**	**-36.0**	dBm	**6 channels (- 7 dB)**

-27.5	-33.8	-29.3	-37.8	-37.0	dBm

8 channels (- 8 dB)

For max dynamic range, Sip should be no higher than "Sip (SFDR)"

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NNEL MASTER OVERLOAD SPECS:

Sov = 57 dBmV for Channel Master CM7777

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C-M: "UHF output capability for 2 input channels at -46 dB cross-modulation. Derate by 5 dB for 4"
"(strong?) input channels and 8 dB for 8 (strong?) input channels."

:GARD OVERLOAD SPECS:

Siv = 29,000 uV (89.2 dBV) for Winegard 29 dB Gain Preamps: AP-2880, 8275, 8800

Siv = 111,000 uV (100.8 dBV)for 17 dB Gain Preamps: AP-2870, 3700, 8700, 8780

Siv = 150,000 uV (103.5 dBV) for Winegard 12 dB Gain HDP-269 Preamp [Old spec said 350,000 uV.]

W-G: "Outputs (actually inputs) stated for 7 VHF and 5 UHF channels at -46 dB (output) cross mod'l'n."

ER BACKOFF CALCULATIONS:

Number Of Equal Pwr Carriers	Peak Pwr	Avg Pwr	Pk/Avg	C-M Specs	Backoffs wrt 2 carr.	W-G Spec	Backoffs wrt 5 carr.	Suggested Backoffs
1	1	0.707	3.0 dB		-6.0 dB		-14.0 dB	-6 dB
2	4	1.414	9.0 dB	0 dB	0.0 dB		-8.0 dB	0 dB
3	9	2.121	12.6 dB		3.6 dB		-4.4 dB	3.6 dB
4	16	2.828	15.1 dB	5 dB	6.1 dB		-1.9 dB	5 dB
5	25	3.535	17.0 dB		8.0 dB	0 dB	0.0 dB	6 dB
6	36	4.242	18.6 dB		9.6 dB		1.6 dB	7 dB
8	64	5.656	21.1 dB	8 dB	12.1 dB		4.1 dB	8 dB

ATIONS:

Lf (dB) = 36.58 + 20 log(MHz) + 20 log (miles) Free Space Loss [Use 32.44 if km]

Sip (dBm) = Pt (dBm) - (Free Space Loss) - (Add'l Loss) + (Ant. Gain) - (Rcv Loss)

Sip (dBm) = Siv (dBmV) - 48.75

Siv (dBuV) = Siv (dBmV) + 60

Siv (dBmV) = Sip (dBm) + 48.75
Sop (dBm) = Sip (dBm) + PreAmp Gain (dB)

USSION:

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Be sure to include loss in Downlead and RF Splitters when calculating max input to HDTV/STB.

An RF attenuator may need to be inserted between Preamp and HDTV/STB. (e.g R-S 15-678)

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ER COMMENTS:

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HDTV and STB maximum input specs are very important, but are usually never disclosed.

ERENCES:

Canadian Research Center (CRC) tests on **PROTOTYPE** ATSC Receivers:
http://www.crc.ca/en/html/crc/home/research/broadcast/rtnt
FCC Office of Engineering Technology tests on STBs/HDTVs available in 2005 & 2006:
FCC_OET TR-05-1017 - Lab Tests of ATSC 8-VSB Reception Performance - Nov2005
FCC_OET 07-TR-1003 - DTV Interference Rejection Thresholds - 221 pgs 30Mar2007

Additional info: http://www.odyseus.nildram.co.uk/Systems_And_Devices_Files/Linearity.pdf
http://www.avsforum.com/avs-vb/showthread.php?p=6163454

File posted on AVSForum, with further explanations:
http://www.avsforum.com/avs-vb/showpost.php?p=15005797&postcount=8148
& Examples: http://www.avsforum.com/avs-vb/showthread.php?p=6206737
http://www.avsforum.com/avs-vb/showthread.php?p=6208266
http://www.avsforum.com/avs-vb/showthread.php?p=6290253