WMMO Orlando, FL

Case Study/Split Level™ Combining

When it was decided to implement HD Radio™ at Cox Radio's WMMO in Orlando, Florida Split Level combining was the method of choice for several reasons.

First, it was desired to use the same antenna as the main analog signal for best possible coverage of the HD Radio signal.

With that premise, two possible methods to generate the HD Radio signal were possible on any type of cost-effective basis. One would be the conventional high level (10 db insertion) approach, and the other would be the newer Split Level design.

With Split Level Combining, in the event of analog transmitter failure, an analog component is always available (at reduced power) from the HD Radio transmitter, so the station increases its up time, on air.

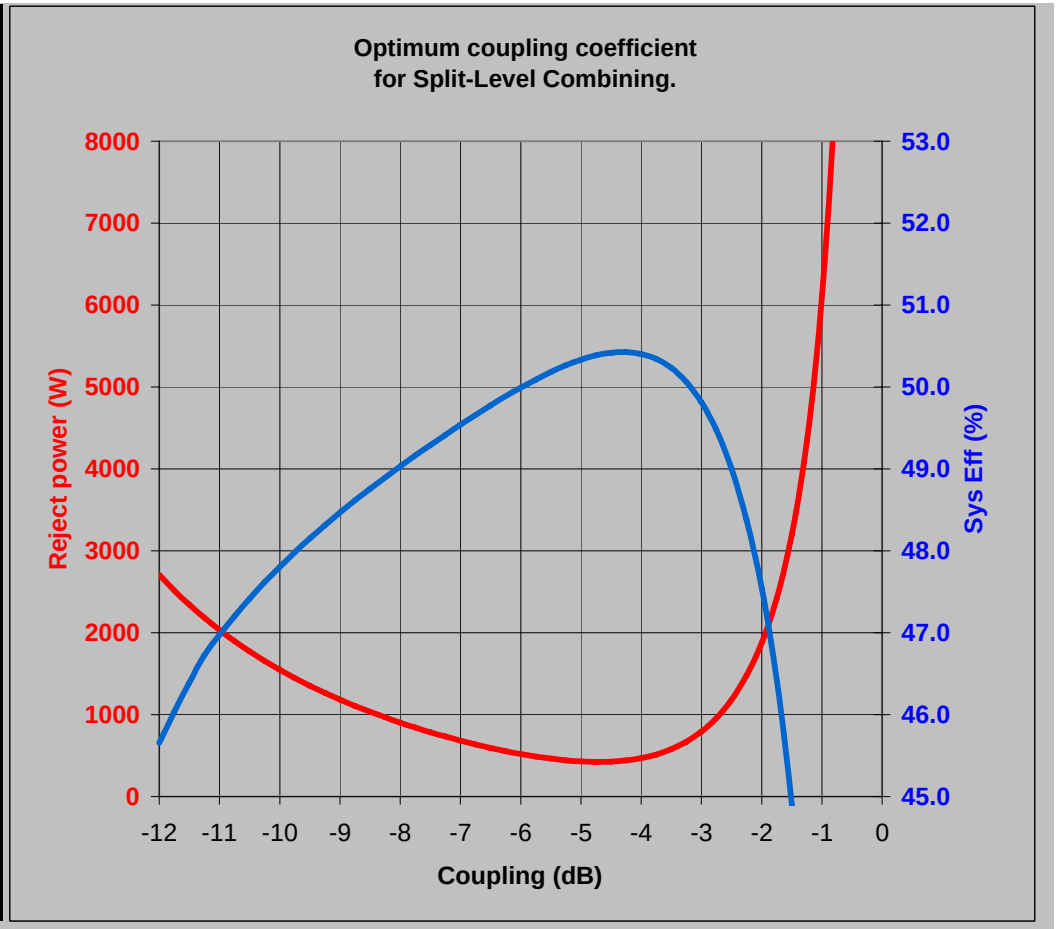
While the HD Radio transmitter could ultimately be switched into the antenna for analog redundancy, the station already had a backup analog transmitter (full power) and it was desired to retain that. The accompanying block diagram shows how the system is interconnected for maximum redundancy in case any component in the main analog, HD Radio transmitter, combiner, or reject load should fail and compromise operation.

Several photographs also detail how HD Radio was implemented, and a typical combined scenario using an analog transmitter and an HD Radio transmitter. Note that there is no difference between conventional "high level" combining using a 10 dB inserter or the 3 dB combiner as used in this situation, in terms of how the faculty is constructed. The differences between Split Level Combining are invisible to the naked eye but include

- A different ratio combiner or coupler
- A lower power reject load (less heat dissipated)
- The FlexStar exciter phases the analog signals for least loss
- The HD Radio transmitter runs "common amplifier" (analog + HD)

This installation was completed in October, 2004 and has been operation flawlessly ever since.

Separate Amplification	Enter TPO (Watt) here: 17,000	Split-Level Combining WMMO
	COUPLER	
-10	Coupling Factor (dB)	-3.01
Z8HD	**ZHD TRANSMITTER**	Z16HD
5,500	Psat (W)	11,000
1,700	HD Power (W)	340
NA	FM Power (W)	5,570
NA	HD/FM Ratio, dB	-12.1
NA	Total RF Power (W)	5,910
3,519	Dissipation (W)	8,469
5,219	AC Power Consumption (W)	14,379
32.6	Overall Efficiency (%)	41.1
	MAIN FM TRANSMITTER	
111.1%	FM Power (% of TPO)	70.9%
18,889	FM Power (W)	12,048
12,593	Dissipation (W)	8,032
31,481	AC Power Consumption (W)	20,079
60	Overall Efficiency (%)	60
	REJECT LOAD	
3,419	Rejected Power (W)	787
	SYSTEM PERFORMANCE	
19,530	Total Dissipation (W)	17,288
36,700	Total AC Power Consumption (W)	34,458
83.4%	Combining Efficiency (%)	95.6%
46.8%	Overall Efficiency (%)	49.8%
Split-Level Calculator Rev E	**Reduction in dissipation**	
	Watts	2,243
	In percentage	-11.5%



HOW TO READ THE SPLIT LEVEL CHART

The left side of the chart shows the example if standard 10 dB insertion is used, and the right side illustrates Split Level Combining.

It is noted that differing power levels may be used in the Split Level configuration but in the 10 dB method, one power must be used.

Under HD Transmitter, Psat = power saturation of the amplifiers (in watts). In S/L we always use maximum for that power transmitter. There is no advantage to de-rating to be "conservative" in a solid-state HD transmitter, and the transmitter runs most efficiently at full saturation.

HD Power is the amount of HD Radio (digital) power in watts that the transmitter develops. It is not necessarily related to the digital ERP.

FM Power is the amount of FM power generated by the transmitter in watts

Total RF power refers to the analog plus HD in the case of the HD transmitter

Total dissipation is the total dissipation of the transmitter's PA in watts

AC Power consumption is that consumed by the respective transmitter in watts

Overall efficiency is based AC to RF conversion efficiency

Under Main FM Transmitter, FM power % of TPO shows what the analog transmitter will be called upon (as a percentage) to output once the station implements HD Radio.

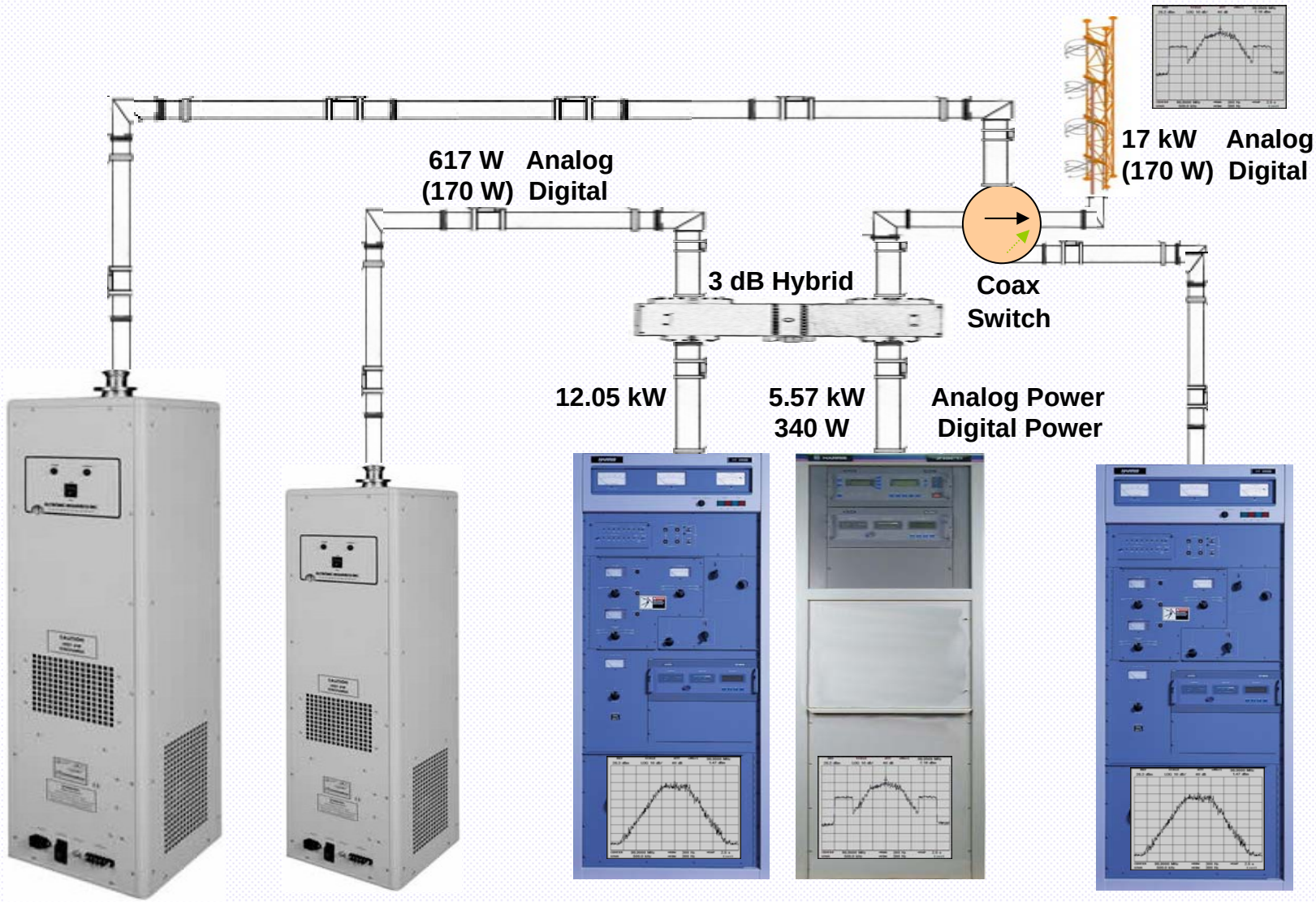
FM Power is what the transmitter will have to output in watts after HD implementation

Reject load – is the power that either system will place into the reject load under normal operating conditions in HD Radio.

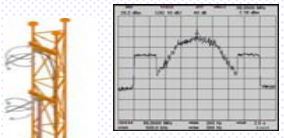
The balance of the numbers should be self explanatory, and in this case we should see a savings in electrical costs of about 3+ kW/h.

The graph is designed to show the optimum coupling ratio (how the combiner is selected in S/L operation) and the impact that coupling ratio has on the reject power load. Generally the coupling ratio is selected which gives lowest reject load power. In the example shown for WMMO, either a 3 dB or 4.77 dB coupler could have been selected.

WMMO Split-Level Combining: 17 kW TPO



WMMO Split-Level Combining: 17 kW TPO



17 kW Analog
(170 W) Digital

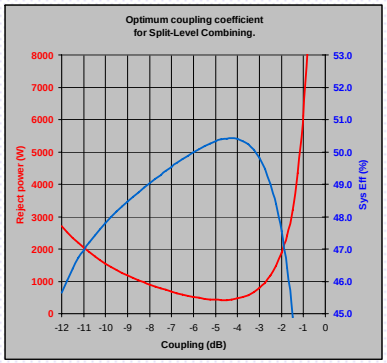
617 W Analog
(170 W) Digital

3 dB Hybrid

12.05 kW

5.57 kW
340 W

Analog Power
Digital Power



Separate Amplification	Enter TPO (Watt) here: 17,000	Split-Level Combining	#NUM!
			35.4
	COUPLER	Select Coupler & TX:	
-10	Coupling Factor (dB)	-3.01	Phase Imbalance (Deg)
Z8HD	ZHD TRANSMITTER	Z16HD	ZHD Power Factor
5,500	Psat (W)	11,000	0.00
1,700	HD Power (W)	340	
NA	FM Power (W)	5,570	
NA	HD/FM Ratio, dB	-12.1	
NA	Total RF Power (W)	5,910	
3,519	Dissipation (W)	8,469	
5,219	AC Power Consumption (W)	14,379	
32.6	Overall Efficiency (%)	41.1	
	MAIN FM TRANSMITTER		
111.1%	FM Power (% of TPO)	70.9%	FM Power Factor
18,889	FM Power (W)	12,048	1.00
12,593	Dissipation (W)	8,032	
31,481	AC Power Consumption (W)	20,079	
60	Overall Efficiency (%)	60	
	REJECT LOAD		
3,419	Rejected Power (W)	787	6,024
	SYSTEM PERFORMANCE		
19,530	Total Dissipation (W)	17,288	
36,700	Total AC Power Consumption (W)	34,458	
83.4%	Combining Efficiency (%)	95.6%	
46.8%	Overall Efficiency (%)	49.8%	
Split-Level Calculator Rev E	Reduction in dissipation		
	Watts	2,243	
	In percentage	-11.5%	

Reject Load

787 W Split Level

3.4 KW with High Level Method

Transmitter 1
Analog

Transmitter 2
Digital / Analog


HARRIS
HT 25CD
HARRIS
HARRIS
ANTENNA REJECT LOAD INTER LOCK
ENABLE
RESET
REJECT
DANGER


HARRIS
HT 25CD
HARRIS
HARRIS
OPTIMOD