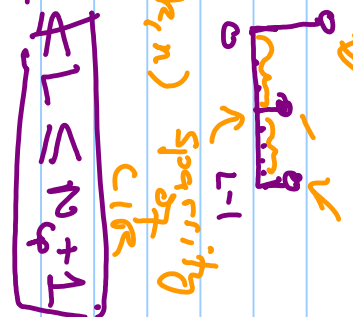


Revisit → Multi-tap Channel → Freq. Response.

Prop # 3  $\bar{q}_n^{-H} \bar{q}_{n,2}^{-H} = e^{-j \frac{2\pi}{N} n k}$   
 → delay.



$$\begin{bmatrix} 1 & 1 & \dots & 1 \\ \bar{q}_0 & \bar{q}_1 & \dots & \bar{q}_{N-1} \end{bmatrix} = \begin{bmatrix} \bar{q}_0 & \dots & \bar{q}_{N/2-1} & \bar{q}_0 & \dots & \bar{q}_{N/2-1} \\ \bar{q}_1 & \dots & \bar{q}_{N/2} & -\bar{q}_1 & \dots & -\bar{q}_{N/2} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \bar{q}_{N/2-1} & \dots & \bar{q}_{N-1} & -\bar{q}_{N/2-1} & \dots & -\bar{q}_{N-1} \end{bmatrix}$$



$L \leq N+1$

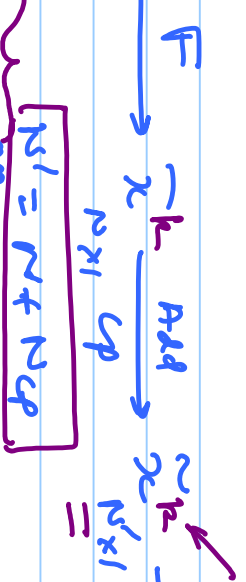
# OFDM

Block Modulation → Multicarrier

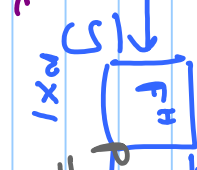
Guard Interval → CP

$$y[k, n] = H[k, n] d[k, n]$$

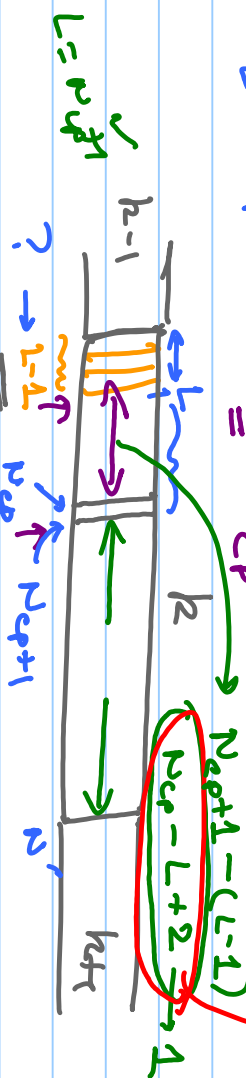
$$d[k, n]$$



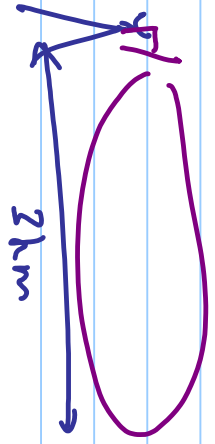
VCN



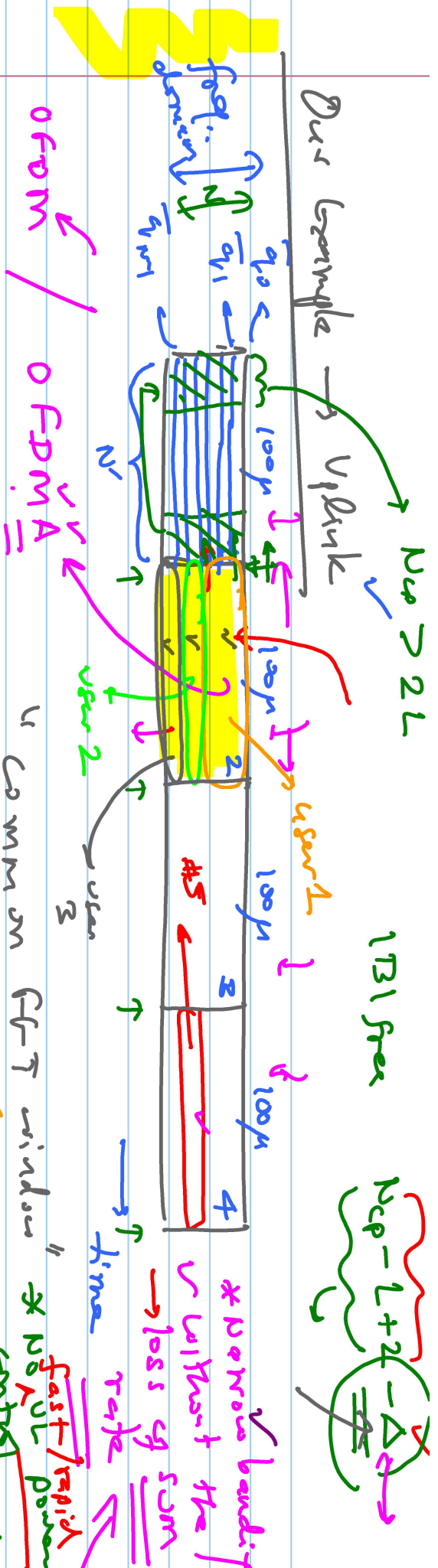
(Q1)  $\sqrt{L}$   $\sqrt{L}$   $\sqrt{L}$



$$N_{cp} > 2L$$



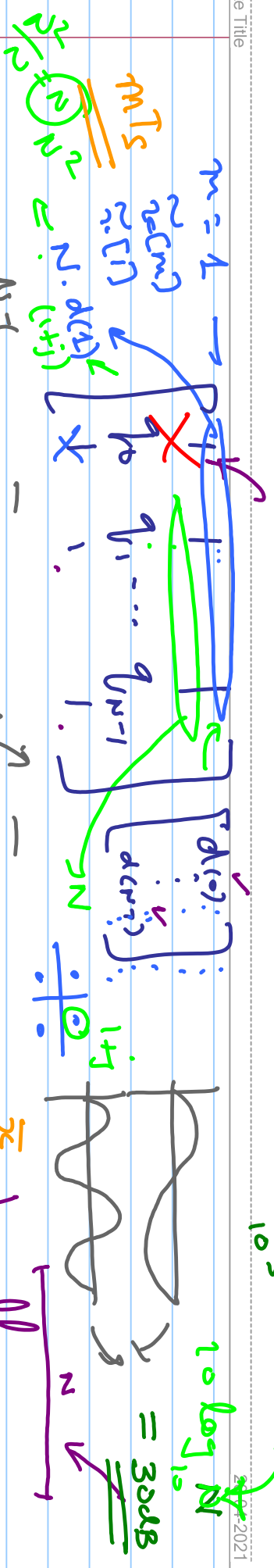
$T_{of} = 10\mu$   
 $T_{cp} = 3\mu$   
 $D_{den} = 15\%$   
 $T_{of} = 5\%$



- OFDM → Freq. Diversity → (Selectivity)
- OFDM → Multiuser Diversity with narrow banding advantage
- Optimal for complexity scales linearly with BW

fast power control required

$$P = 10^{24} \times 10^3$$

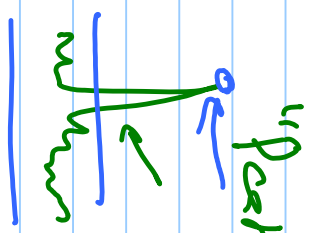


$$P_{\text{total}} = \sum_{n=1}^{N-1} d_n \bar{q}(n) + \frac{d(0)}{N} \bar{q}(0)$$

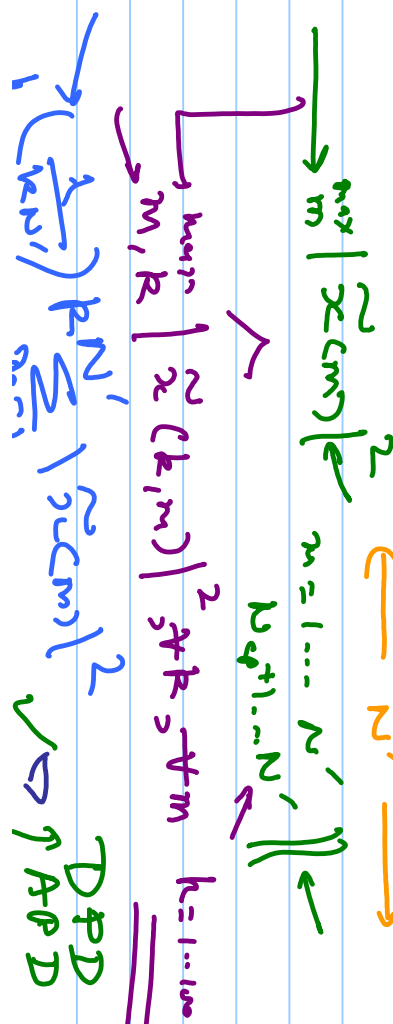
CFR ✓

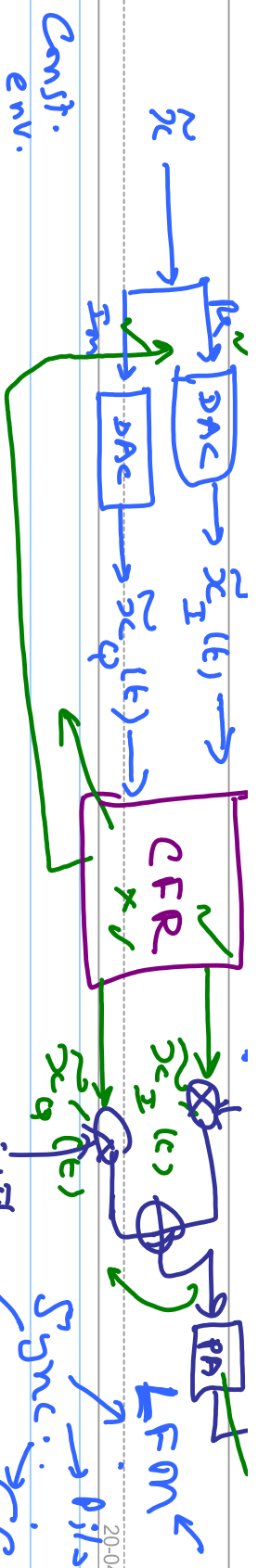
"Crest Factor"  
"Peak Reduction"

PAOP reduction



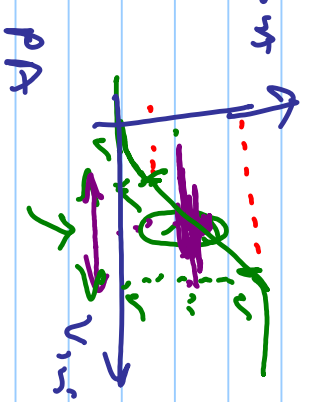
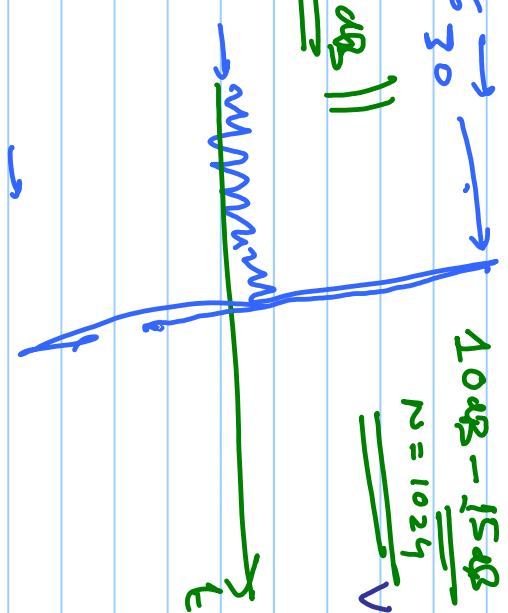
"Peak Power"





Const. env.  
 PAOR > 1  
 SRRC ~ PAOR ~ 2 dB

CCDF



PA  
 Back-off 99%  
 30 dB

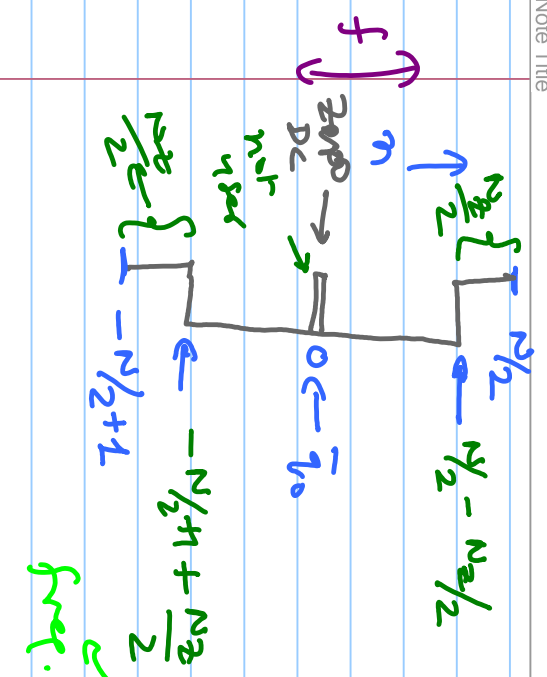
sync. → P/15 dB  
 sync. → GCL

## Other Block Modulation Schemes

$N_g \rightarrow$  "Zero" subcarrier for bandwidth sharing

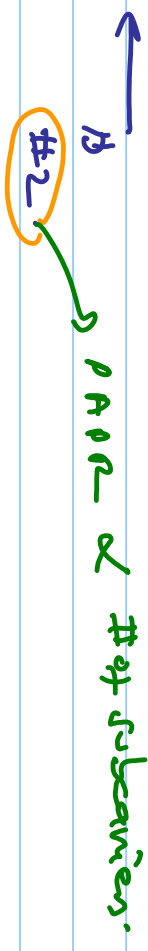
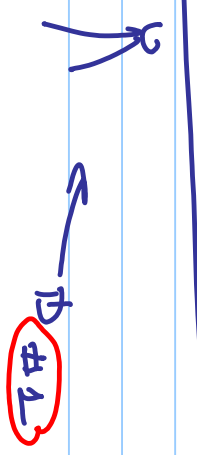
Total # of Zero subcarrier =  $N_g + 1 \leftarrow$  DC subcarrier

$N \rightarrow N - (N_g + 1) = N_u \leftarrow$  used subcarrier



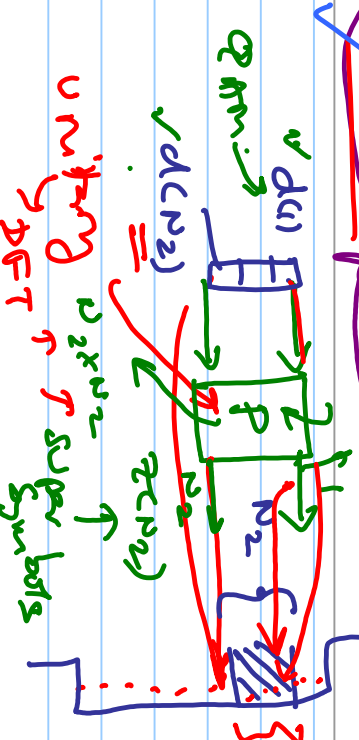
10 logs  $N_u$

Recall uplink OFDM ✓



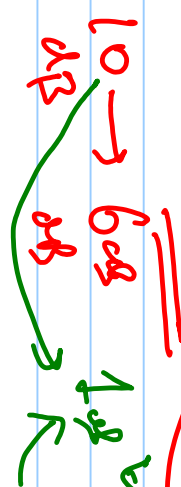
(1)

Pre-coded OFDM

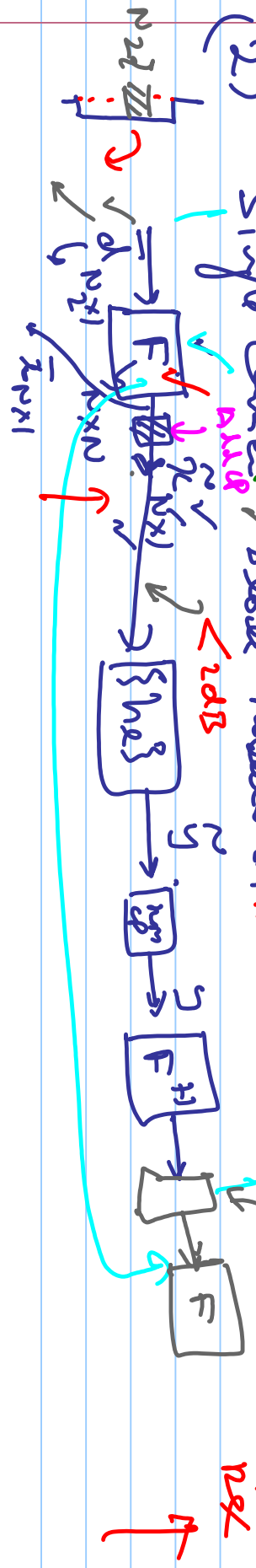


SC-FDMA

OFDMA



(2) Single Carrier Block Modulation



Low complexity  
"up to 100x"



•

•







