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Two Polarization Equalization for Channel Interference Suppression

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INTRODUCTION

The purpose

obtain research results toward effective methods for combating the deleterious effects of various impairments arising in digital data transmission over dually polarized communication channels

The Problem

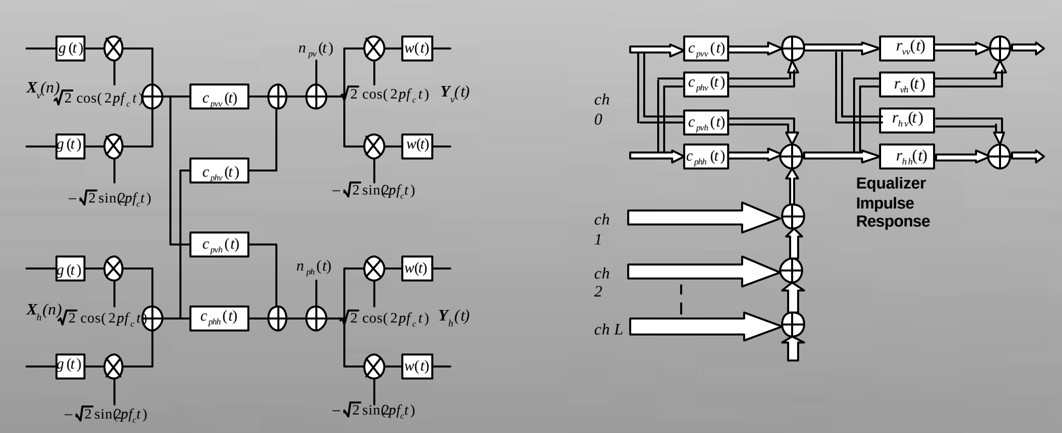
- Co-Channel Interference (CCI)
- Adjacent-Channel Interference (ACI)
- Cross-Polarization Interference (CPI)

The Solution

Explore a new design possibility using:

- Channel equalization
- Wide receiver and transmitter bandwidth
- Derive a mathematical solution
- Conditions and limitations

SYSTEM MODEL



PASSBAND and BASEBAND SYSTEM MODEL

Channel Impulse Response Matrix:

$$C(f)=\begin{bmatrix} c_{bvv}(f) & c_{bvh}(f) \\ c_{bhv}(f) & c_{bhh}(f) \end{bmatrix}$$

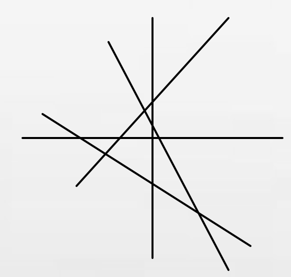
Equalizer Impulse Response Matrix:

$$R(f)=\begin{bmatrix} r_{vv}(f) & r_{vh}(f) \\ r_{hv}(f) & r_{hh}(f) \end{bmatrix}$$

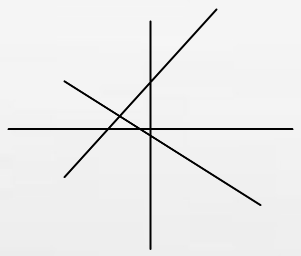
Finding the Receiver Impulse Response

Combined Channel Impulse Response:

$$H(f) = C(f)R(f)$$



Case One: The number of equations is greater than the number of unknowns, there is no solution



Case Two: The number of equations is less or equal to the number of unknowns, there will be at least one solution

the following conditions must be true:

$$\frac{1}{T}\sum_{k=-\infty}^{+\infty} \boldsymbol{H}_0\left(f+\frac{k}{T}\right) = \boldsymbol{I} \qquad \frac{1}{T}\sum_{k=-\infty}^{+\infty} \boldsymbol{H}_l\left(f+\frac{k}{T}\right) = 0$$

Suppose the receiver is band limited, $-\frac{1}{2T} < f < \frac{1}{2T}$

- There are two ACI channels, ch1 and ch2
- They produce eight equations
- Plus four more equations by the desired channel
- Thus total number of equations is 12

From frequency domain analysis

- The total number of unknowns is 12
- Thus a unique solution exits

Repeat the analysis based on above method, we will find the area where the solution exists

The Results

Nar: number of ACI signals

$$N_{ar} = \begin{cases} 2\,int\left(\frac{B_t + B_{ri}}{c_t}\right), c_t \neq 0, c_t < 2B_t \\ 0, c_t \neq 0, c_t \geq 2B_t \end{cases}$$

Bt: relative transmitter bandwidth

Ct: relative carrier spacing

NE: number of equations

$$N_E = 4(1 + N_{ar})$$

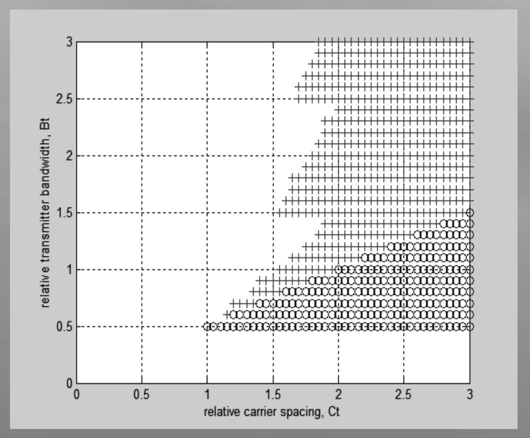
Bri takes the values as the following:

$$B_{ri} = \left\{\frac{1}{2}, \frac{2}{2}, \frac{3}{2}, ..., \frac{int(2B_r)}{2}\right\}$$

Nu: number of unknowns

$$N_u = \begin{cases} 0, 2B_t < 1 \\ 8B_{ri}, 2B_t \geq 1, c_t < 2B_t \\ 4[int(2\min(B_{ri}; B_t)) + 1], 2B_t \geq 1, c_t \leq 2B_t \end{cases}$$

When $B_r = B_t$, the region where the Equalizer can suppress ACI, CCI and CPI is shown below:



The region where ACI, CCI and CPI can be suppressed is shown by '+' and 'o'

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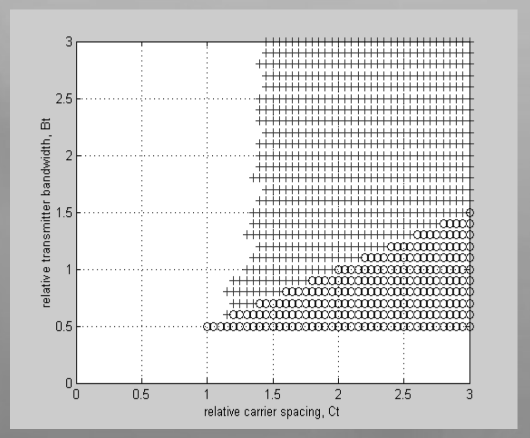

The region where ACI, CCI and CPI can be suppressed is shown by '+' and 'o'