



Quality control and process management systems

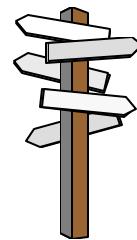
CD - HF signals and tracking

Peter Pohl

Research & Development

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1. Read-out of a disc
2. Analog signals
3. Tracking system

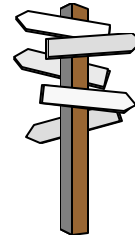


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Information layer

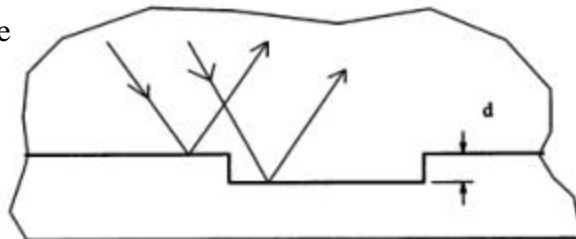


$OPD \approx 2 \cdot d$... Optical path difference

$$\lambda \approx 2 \cdot \frac{OPD}{\lambda} \approx 4 \cdot \frac{d}{\lambda}$$

λ ... Phase difference

d ... Pit depth



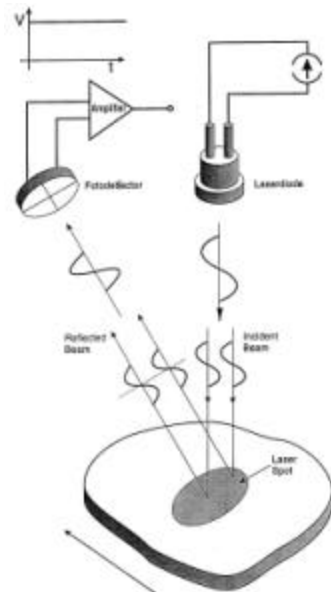


When the **light reflected** by a **pit** is in antiphase with the light reflected by the surrounding area a maximum **extinction** of the light occurs.

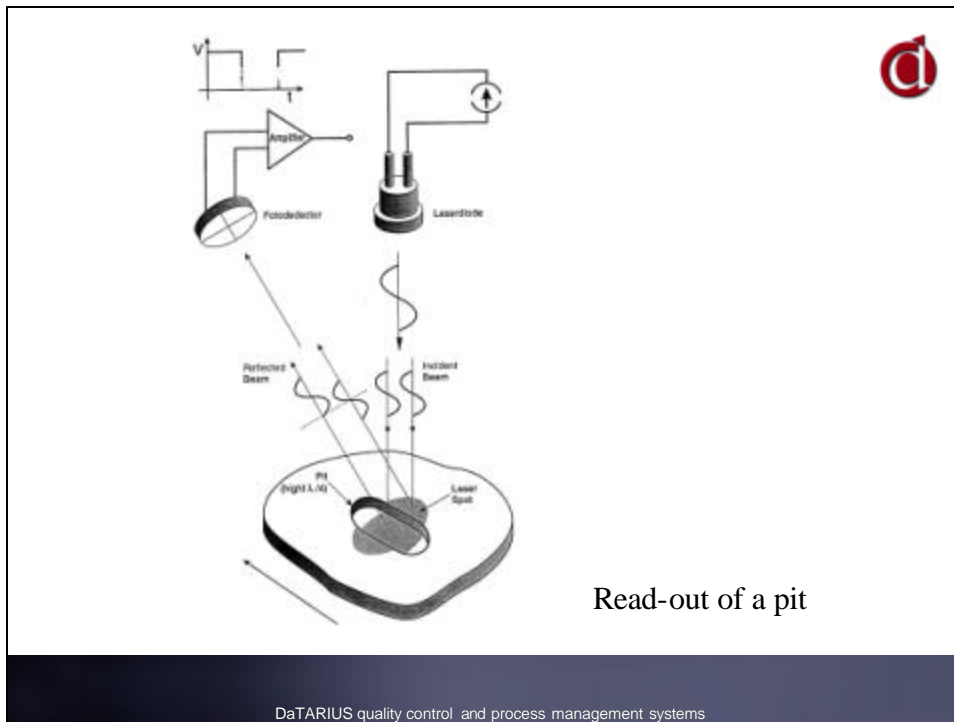
Another criterion is also that the intensity of the light in phase opposition is properly balanced.

Thus the light reflected back to the photodetector is modulated according to the relief of the information layer.

The signal level obtained by the **reflection** of a **land area** is the so-called **I_{top}**. It is the maximum amount of light captured by the focus lens.



Read-out of a land



d

Due to the **limited aperture** it is only possible to **collect** the **0th** and the **two 1st orders** of the reflected beam.

Itop is in principle proportional to the reflectivity of the disc and the transmission coefficient of the polycarbonate.

However, it is possible that two discs with equal reflectivity and transmission coefficient have different Itop values:

- » disc acts in radial direction as diffraction grating
- » the incident spherical wave will be diffracted into several orders
- » angle and intensity depends on pit structure and depth
- » 2nd and higher orders cannot be counted

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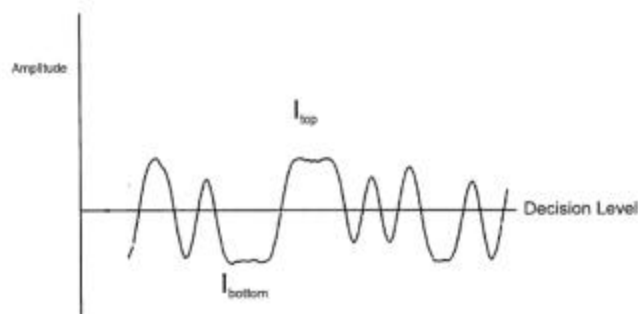


The **minimum signal level** is referred to as **I_{bottom}** (I_{bot}).

- » With a pit depth of $\lambda/4$, I_{bot} would be theoretically zero on condition that the intensity of the light striking the pit is as high as the intensity reflected by the land
- » In this case the modulation would be maximum

If the pit depth deviates from $\lambda/4$ the light is not extinguished entirely.

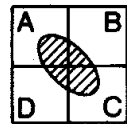
To reliably retrieve the information on the disc it is necessary to reach a large difference between I_{top} and I_{bot}.



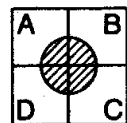
In the REDBOOK this difference is named as **I₁₁/I_{top}** (**I_{1T}**) and is defined as follows:

$$\frac{I_{11}}{I_{top}} = \frac{I_{top} - I_{bot}}{I_{top}}$$

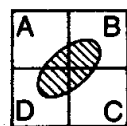
Astigmatic focusing



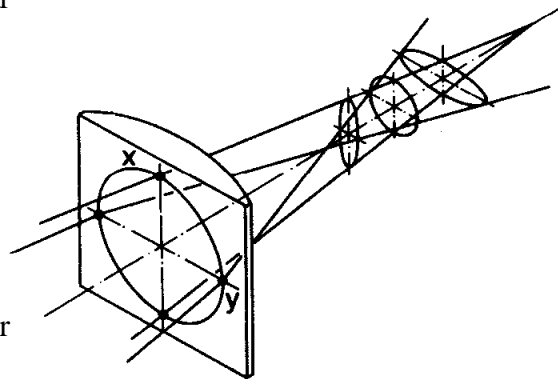
Disc too near



In focus



Disc too far

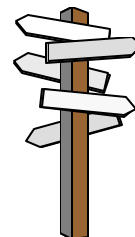


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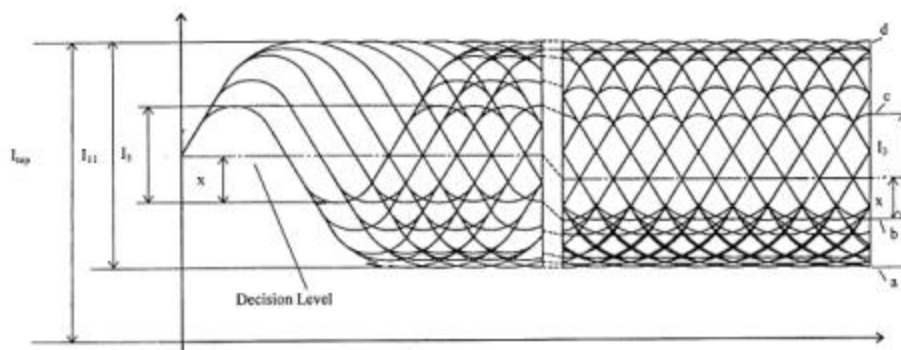
Eye pattern



When the signal of several pits and lands are superimposed, one can recognize the so called eye-pattern.

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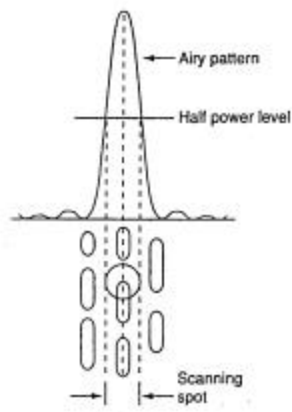
Eye pattern



Asymmetry:

$$Asy = \frac{\frac{d-a}{2} - \frac{c-b}{2}}{d-a} \cdot 100\% = \frac{\frac{d-c}{2} - \frac{a-b}{2}}{d-a} \cdot 100\%$$

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We define **Cross talk XT** as the ratio of the HF amplitude with the spot centered on track and the amplitude with the spot between two tracks.

$$XT? \frac{I_{11G}}{I_{11T}}$$

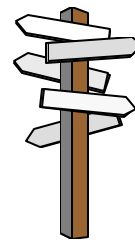
Where **I_{11G}** is the signal amplitude between the tracks and

I_{11T} the signal amplitude with the spot centered on track

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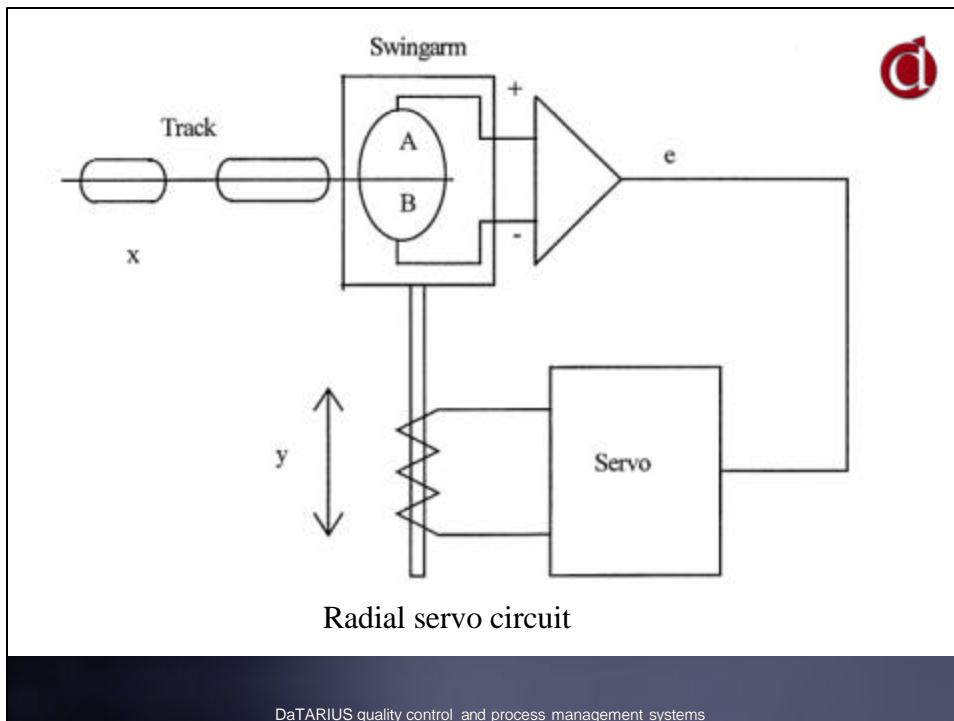
Servo system



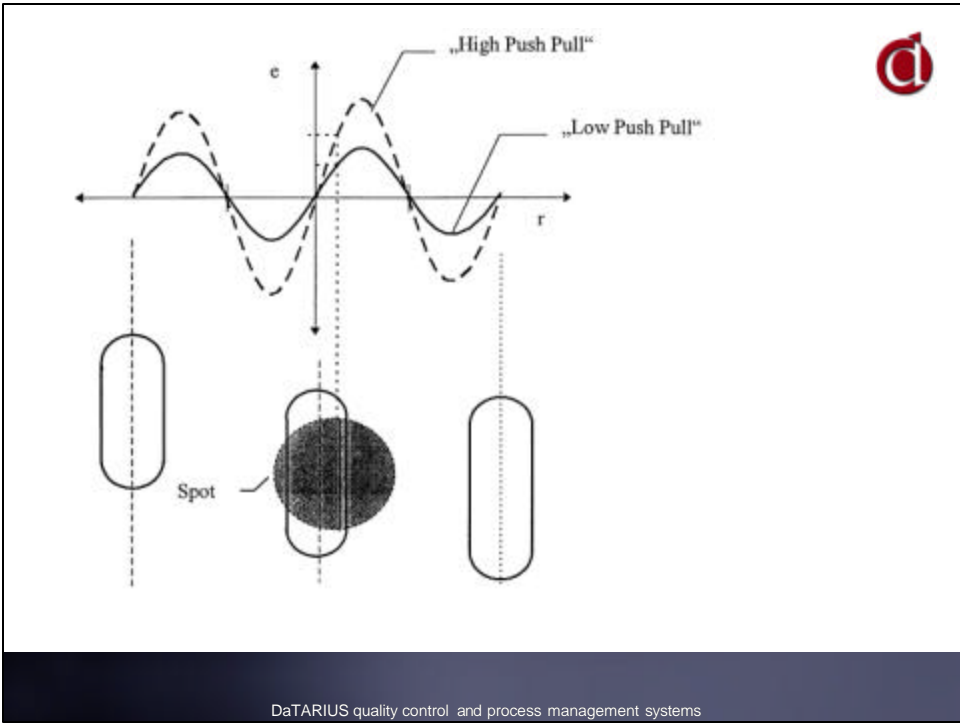
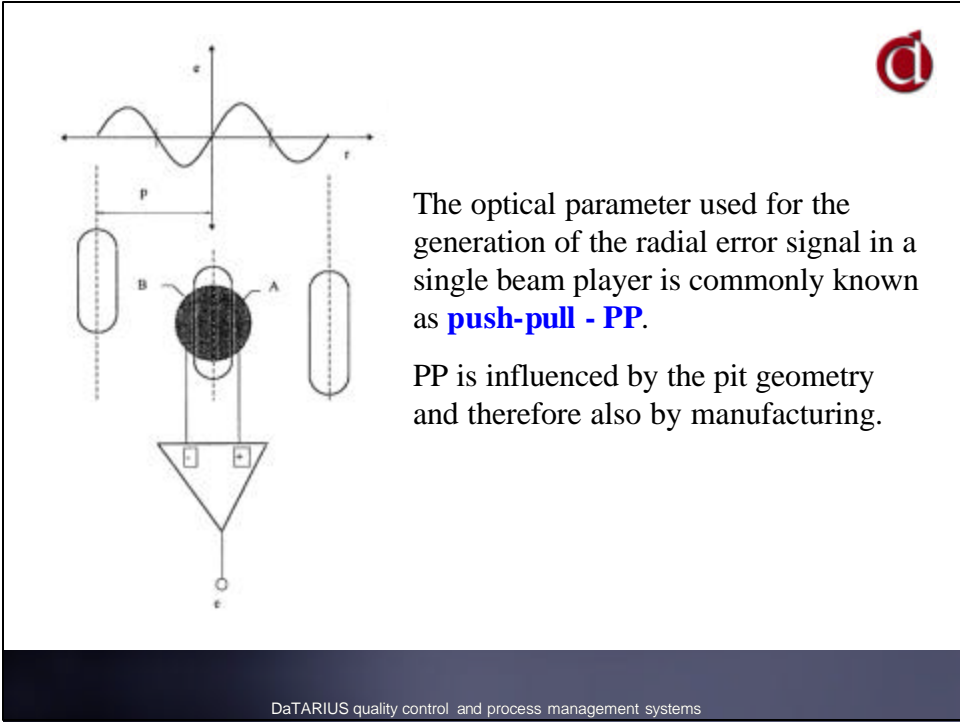
Compared with the gramophone where the needle of the pickup is guided by means of the track no such steering mechanism is available in the Compact Disc.

Therefore the focuses spot must be driven by a servo mechanism, so that the track is followed precisely.

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Modeling of tracking signal versus HF-signal

