Block diagram algebra

Ex1 : consider the block diagram in the figure below consist of one block and summing junction. Find the block diagram consist of two blocks and summing junction.

Sol.

rA-b=e

A(r-(1/A) b)=e

Ex2 : consider the feedback system in the figure below ,find the block diagram of unity feedback system that consist of same number of the blocks and summing junction.

Sol.

(r-b)G=C (1)

b=Ck (2)

(r- Ck)G=C (3)

$rG_1=C(1+kG)$

$$C = \left(r.\frac{1}{k} - C\right)kG \qquad (4)$$

Modes of controller action

There are three basic modes of feedback controller:

1. Proportional mode, P.
2. Integral mode, I.
3. Derivative mode, D.

1. Proportional mode (P controller)

It's actuating the output is proportional to the error.

The transfer function of this mode is:

$P(t)=K_c\ E(t)+P_0$

$G_c(s)=\frac{P(s)}{E(s)}=K_C$

P(s) : The controller output (pneumatic ,air pressure =3-15 psig or current 4-20 mA D.C)

K_c :proportional gain of the controller

E(s) :controller input(error signal)

P_o :steady state controller output when E=0(controller bias signal)

Units of k_c =unit pressure /unit of error

At steady state , E=0,$P(t)=P^0=P_o$ (1)

At transient state: $P'(t)=P_o+K_c\ E'(t)$

Subtracting Eq.(1) from (2)

$$P(t)=K_c\ E(t)$$

$$P(s)=K_c\ E(s)$$

$$G_c(s)=\frac{P(s)}{E(s)}=\frac{K_c\ E(s)}{E(s)}=K_c$$

$$K_C=\frac{\Delta P_{max}}{\Delta E}$$

The proportional band P.B. is:

$$P.B\%=\frac{\Delta E}{\Delta E_{max}}\times 100$$

Also we can find the proportional band from the following equation :

$$P.B\%=\frac{1}{K_C}\frac{\Delta P_{max}}{\Delta E_{max}}\times 100$$

The Controller action

There are two action:

1. Direct action

$P=P_0 - K_c E(t)$

2. Reverse action

$P= P_0 + K_c (C_{set} – C_m)$