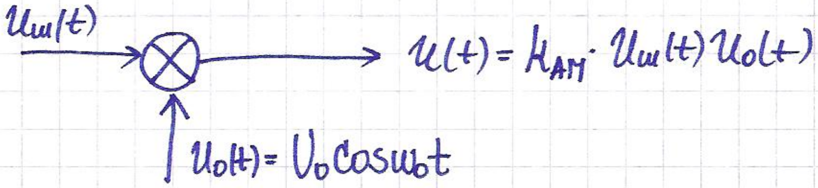
AMPLITUDSKE MODULACIJE

-AM -DSB - DOUBLE-SIDE BAND



$u_m(t) \rightarrow$ MODULIŠUĆI SIGNAL

$u_0(t) \rightarrow$ NOSILAC

$u(t) \rightarrow$ MODULISANI SIGNAL

$U_0 = const$
$\omega_0 = const$ $\wedge$ $\omega_0 \gg \omega_m$

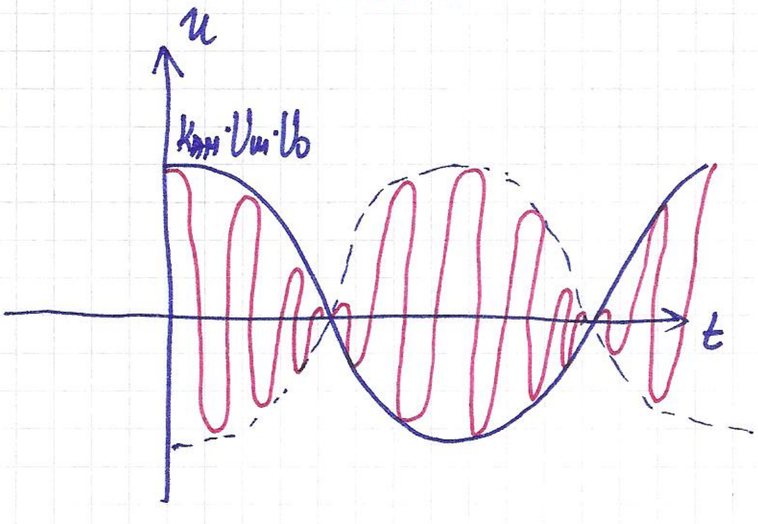
$$u(t) = k_{AM} \cdot u_m(t) \cdot u_0(t) = k_{AM} \cdot U_0 \cdot u_m(t) \cdot \cos \omega_0 t$$

$$u(t) = \frac{1}{2} k_{AM} \cdot U_0 \left(u_m(t) e^{j\omega_0 t} + u_m(t) e^{-j\omega_0 t} \right)$$

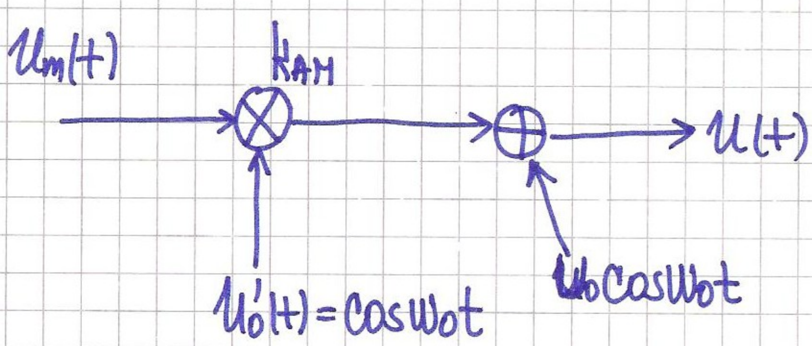
$$\cos \omega_0 t = \frac{1}{2} \left(e^{j\omega_0 t} + e^{-j\omega_0 t} \right)$$

$$U(j\omega) = \frac{1}{2} k_{AM} \cdot U_0 \left(U_m(j(\omega - \omega_0)) + U_m(j(\omega + \omega_0)) \right)$$

$$u(t) = \underbrace{k_{AM} \cdot U_m \cdot U_0 \cos \omega_m t}_{\text{NOVA AMPLITUDA}} \cdot \cos \omega_0 t$$



AM-CAM - CONVENTIONAL AMPLITUDE MODULATION



$$u(t) = U_0\cos\omega_0 t + k_{AM}\cdot U_m(t)\cos\omega_0 t$$

$u_m(t) = U_m\cdot m(t)$, $U_m \rightarrow$ AMPLITUDA

$|m(t)| < 1$ – NORMIRANI SIGNAL (MODULIŠUĆI)

$$u(t) = U_0\left(1 + \underbrace{\frac{k_{AM}\cdot U_m}{U_0}}_{\downarrow} m(t)\right)\cos\omega_0 t$$

m_0 – STEPEN (INDEKS) MODULACIJE

$$u_{AM-CAM}(t) = \underbrace{U_0\left(1 + m_0 m(t)\right)}_{\text{SPORA PROMENA}}\cos\omega_0 t$$

$$\Downarrow$$

$$u_{AM-CAM}(t) = u_0(t)\cdot\cos\omega_0 t$$

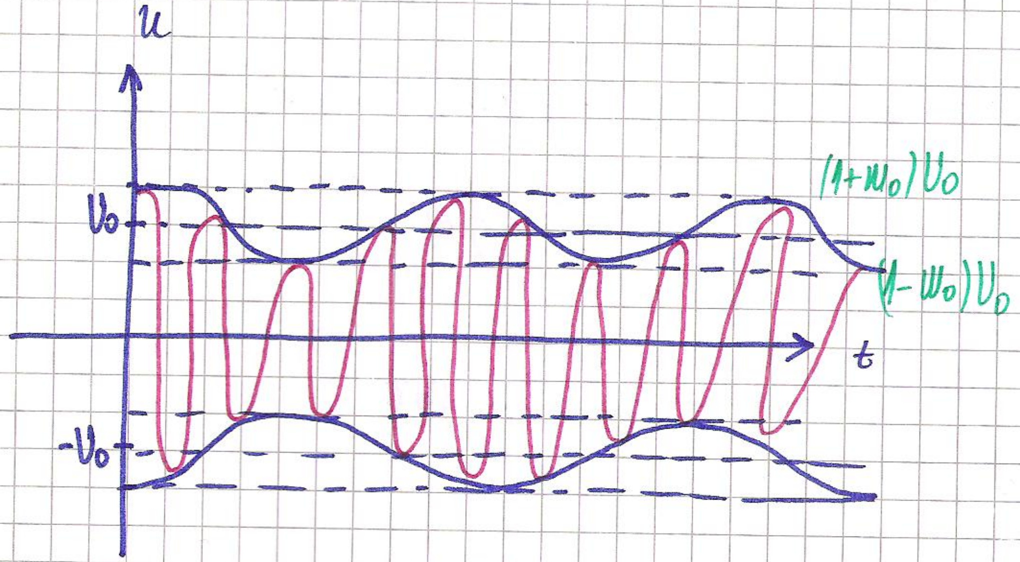
$$u_0(t) = U_0\left(1 + m_0 m(t)\right)$$

$m(t) = \cos \omega_m t$

$u_m(t) = U_m \cos \omega_m t$

$u(t) = U_0 (1 + m_0 m(t)) \cos \omega_0 t$

$u(t) = U_0 (1 + m_0 \cos \omega_m t) \cos \omega_0 t$



- HILBERTOV TRANSFORMATOR

$x(t) \longrightarrow \boxed{HT} \longrightarrow y(t)$

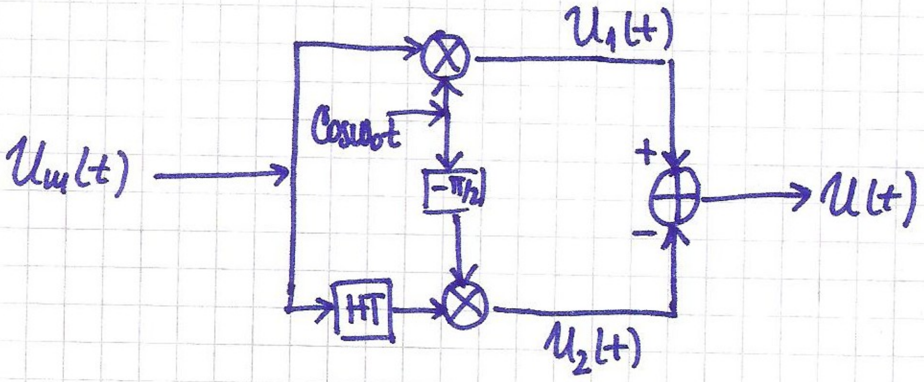
$$\mathrm{sgn}\,\omega = \begin{cases} 1, & \omega > 0 \\ -1, & \omega < 0 \end{cases}$$

$$H_{HT}(j\omega) = -j\,\mathrm{sgn}\,\omega = \begin{cases} -j, & \omega > 0 \\ j, & \omega < 0 \end{cases} = \begin{cases} e^{-j\pi/2}, & \omega > 0 \\ e^{j\pi/2}, & \omega < 0 \end{cases}$$

AMPLITUDSKO POJAČANJE $\quad |H_{HT}(j\omega)| = 1$

$$\arg H_{HT}(j\omega) = \begin{cases} -\pi/2, & \omega > 0 \\ \pi/2, & \omega < 0 \end{cases}$$

AM-SSB - Single-side band



USB (za LSB $\overset{+}{\underset{+}{\oplus}}$)

$$u(t) = u_1(t) - u_2(t) \qquad HT(u_m(t)) = \hat{u}_m(t)$$

$$u_1(t) = u_m(t)\cos\omega_0 t \longrightarrow \frac{1}{2}e^{j\omega_0 t} + \frac{1}{2}e^{-j\omega_0 t}$$

$$u_2(t) = \hat{u}_m(t)\overbrace{\cos(\omega_0 t - \pi/2)}^{\sin\omega_0 t} = \hat{u}_m(t)\sin\omega_0 t$$

$$u_m(t) = \frac{1}{2\pi}\int_{-\omega_m}^{\omega_m} U_m(j\omega)e^{j\omega t}\,d\omega$$

$$u_1(t) = \frac{1}{2\pi}\int_{-\omega_m}^{\omega_m}\frac{U_m(j\omega)}{2}e^{j(\omega+\omega_0)t}\,d\omega + \frac{1}{2\pi}\int_{-\omega_m}^{\omega_m}\frac{U_m(j\omega)}{2}e^{j(\omega-\omega_0)t}\,d\omega$$

$\lambda = \omega + \omega_0$

$d\lambda = d\omega$

$\omega = \lambda - \omega_0$

$\mu = \omega - \omega_0$

$d\mu = d\omega$

$\mu + \omega_0 = \omega$

$$\Downarrow$$

$$u_1(t) = \frac{1}{2\pi}\int_{\omega_0-\omega_m}^{\omega_0+\omega_m}\frac{U_m(j(\lambda-\omega_0))}{2}e^{j\lambda t}\,d\lambda + \frac{1}{2\pi}\int_{-\omega_0-\omega_m}^{-\omega_0+\omega_m}\frac{U_m(j(\mu+\omega_0))}{2}e^{j\mu t}\,d\mu$$

μ i λ SE ZAMENE SA ω

$$\sin w_0 t = \frac{1}{2j} e^{jw_0 t} + \frac{1}{2j} e^{-jw_0 t}$$

$$\hat{u}_m(t) = \frac{1}{2\pi}\int_0^{w_m} (-j)\cdot U_m(jw)\, e^{jwt}\, dw + \frac{1}{2\pi}\int_{-w_m}^{0} j\cdot U_m(jw)\, e^{jwt}\, dw$$

$$u_2(t) = \frac{1}{2\pi}\int_0^{w_m} \left(-\frac{U_m(jw)}{2}\right) e^{j(w+w_0)t}\, dw + \frac{1}{2\pi}\int_0^{w_m} \frac{U_m(jw)}{2}\, e^{j(w-w_0)t}\, dw +$$

$$+ \frac{1}{2\pi}\int_{-w_m}^{0} \frac{U_m(jw)}{2}\, e^{j(w+w_0)t}\, dw + \frac{1}{2\pi}\int_{-w_m}^{0} \left(-\frac{U_m(jw)}{2}\right) e^{j(w-w_0)}\, dw$$

ISTIM SMENAMA KAO ZA $u_1(t)$, $u_2(t)$ SE DOVEDE NA:

$$u_2(t) = \frac{1}{2\pi}\left[\int_{w_0}^{w_0+w_m} \frac{-U_m(j(w-w_0))}{2}\, e^{jwt}\, dw + \int_{-w_0}^{-w_0+w_m} \frac{U_m(j(w+w_0))}{2}\, e^{jwt}\, dw + \int_{w_0-w_m}^{w_0} \frac{U_m(j(w-w_0))}{2}\, e^{jwt}\, dw +\right.$$

$$\left. + \int_{-w_m-w_0}^{-w_0} \left(-\frac{U_m(j(w+w_0))}{2}\right) e^{jwt}\, dw \right]$$

PA JE:

$$u_1(t) - u_2(t) = \frac{1}{2\pi}\int_{w_0}^{w_0+w_m} U_m(j(w-w_0))\, e^{jwt}\, dw + \frac{1}{2\pi}\int_{-w_0-w_m}^{-w_0} U_m(j(w+w_0))\, e^{jwt}\, dw$$

GORNJI BOCNI OPSEZI