Modify the Lunar Landing Guidance Equations to Compensate for Computation, Throttle, FINDCDUW, & Attitude Control Lags.

See attached sheet.

See attached sheet.
1.5 Reason for Change:

Attitude oscillations have been observed during the terminal part of automatic landings. It appears that the observed oscillations are wholly or partly due to the lags between state vector time and the realization of the guidance commands by the two control systems, the engine throttle servo and the attitude control system. (The oscillations were observed with negligible LR errors and no terrain slopes or irregularities.)

1.6 Description of Change:

Modify the guidance equations to allow the guidance commands to be projected forward to compensate for the system lags. The following equations should be programmed.

\[ T_{go}^* = T_{go} - \tau \]

\[ R = \frac{T_{go}^*}{T_{go}} \]

\[ \alpha_G = R(3R - 2)(12/T_{go}^2)[r_D - (r_o + T_{go}v_o)] - R(4R - 3)(6/T_{go})(v_D - v_o) \]

\[ + [1 + 6R(R - 1)]a_{DG} \]

where \( r_o \), \( v_o \), and \( T_{go} \) are the position, velocity and time-to-go at the last PIPTIME, \( t = t_o \). (See LUMINARY Memo #83 for derivation.) Place the quantity \( \tau \) into erasable memory. It will be about 3 seconds.

It is also desirable to phase the FINDCDUW output command before the throttle output command because the two control systems, (FINDCDUW + DAP) and throttle servo do not have the same time constants. FINDCDUW output commands should be computed before the throttle output command.
1.6 Continued

At some value of $T_{go}$ (TBD), the guidance law should be changed from the above equation to a simple velocity-nulling law.

$$a_{TC} = \left( v_D - v_0 \right) / \tau_1$$

thereby relaxing the positional constraint when it becomes impractical to maintain it. This modification, then, represents a minimum change from the current program design. The value of $T_{go}$ at which the guidance law is changed will be established in an erasable register.