AN001: ENHANCED PEAK CURRENT FOR LINEAR AMPLIFIERS

An enhanced peak current capability for LA75 series allows faster actuator charging thanks to a larger output current during a limited time. This feature increases the power bandwidth as well for low repetition rate signals.

I. APPLICATION FOR SQUARE WAVES SIGNALS

The new peak current capability permits fast charge of actuators. Notably, small actuators can be loaded up to 3 times faster than before.

The next table shows the different current limitations of the linear amplifiers. The “continuous output current” is the current that can be delivered for an indefinite amount of time by the amplifier whereas the peak current can only be delivered during a limited duration “td”. Since the peak current and the duration are constant, the product I × t equals a constant charge Qd, useful to compute the rise/fall time as we will see in the next paragraph.

Amplifier	LA75A	LA75B	LA75C
CONTINUOUS OUTPUT CURRENT (IC)	90 MA	0.3 6A	2.4 A
OUTPUT PEAK CURRENT (±10%) (IP)	0.3 A	1.13 A	8 A
DURATION (TD)	600 µS	600 µS	600 µS
EQUIVALENT CHARGE (QD)	180 µC	678 µC	4800 µC

II. SQUARE WAVE EXAMPLE

The enhanced peak current capability acts as a standard current limitation but with a higher current value and a limited duration. Concretely, it results in two slopes on the voltage waveform (See Figure 1).

Here an example with a LA75B with, and without the new feature on 7 µF (See Figure 2). In this particular case, the rise time is twice faster.

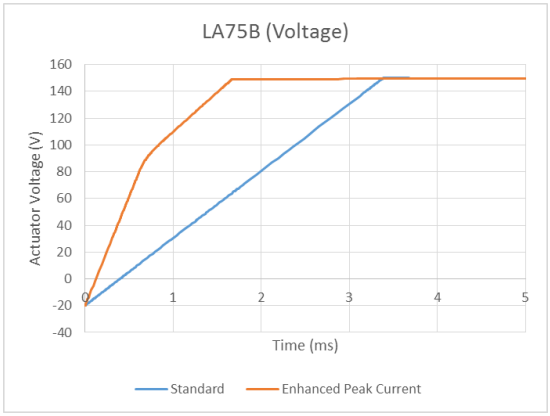

Figure 1: Actuator's voltage with and without peak current capability

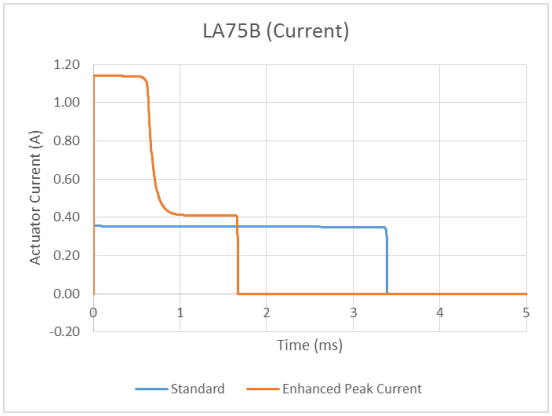

Figure 2: Actuator's current with and without peak current capability

The first slope on the voltage waveform corresponds to the duration of the peak current, during “td” the current is higher (Ip) then it returns to its “continuous” value (Ic) which matches with the second slope.

III. HOW TO COMPUTE THE TOTAL RISE/FALL TIME FOR SQUARE WAVE SIGNALS?

To compute the rise/fall time, the relation between charge, voltage and capacitance may be recalled:

$$Q = CU$$

Where C is the blocked capacitance of the actuators, U the **desired variation of voltage**.

With no peak current capability the rise time can be computed using the following equation:

$$t = \frac{Q}{Ic} = \frac{CU}{Ic}$$

Where Ic is the continuous current of the amplifier.

With peak current capability, there are two cases:

- When the actuator charge is **lower** than the charge Qd.
- When the actuator charge is **higher** than the charge Qd.

When the actuator charge is lower than the charge Qd

The last equation remains correct, we only have to consider the peak current instead of the continuous current:

$$t = \frac{Q}{Ip}$$

In this case, the charge time is at least 3 time faster.

When the actuator charge is higher than the charge Qd

The continuous output current will be used to charge the actuator after the peak current finishes.

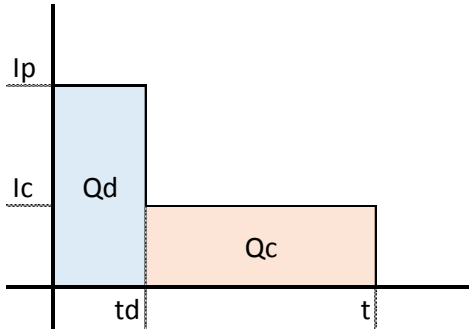

Figure 3: Qd is constant and independent of the load, whereas Qc depends on the load

The relation becomes:

$$t = \frac{Q - Qd}{Ic} + td$$

Note that it remains an approximation because the current smoothly decrease during the transition between peak to continuous current (See Figure 2).

IV. Repetition rate

The peak current duration reduces as the repetition rate (frequency) increases in order to maintain protection of the power transistors. If the frequency is higher than 20 Hz, the duration will decrease, see the following graph and the updated formula to predict the total rise time.

$$t = \frac{Q - Ip\ td}{Ic} + td$$

Use the following abacus to find “td” for a given frequency and insert in the last equation to compute the rise time.

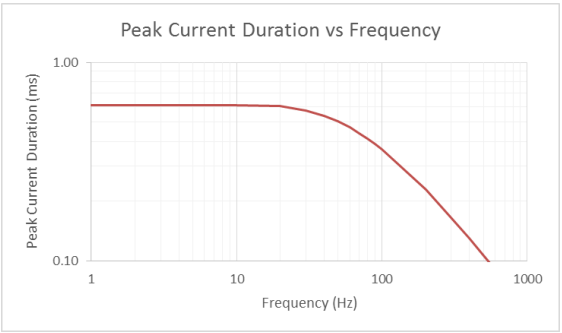

Figure 4: Peak current duration (td) vs frequency for square wave signals

V. Sinus waveforms and extended power bandwidth

The peak current capability benefits to sinus waveforms as well. An extended power bandwidth can be plotted. Note that it is limited to about two cycles.

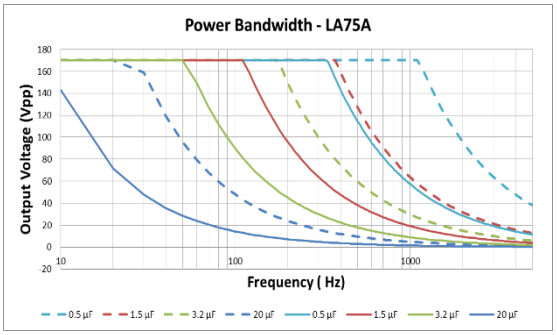

Figure 5: Power bandwidth of a standard LA75A (plain) and extended power bandwidth (dotted)

The next curves show the behaviour of a standard LA75B and a LA75B with peak current capability at 500 Hz on 3 µF. The first two cycles are perfectly reproduced thanks to the peak current capability, starting from the second cycle, the timer effectively limits the output current.

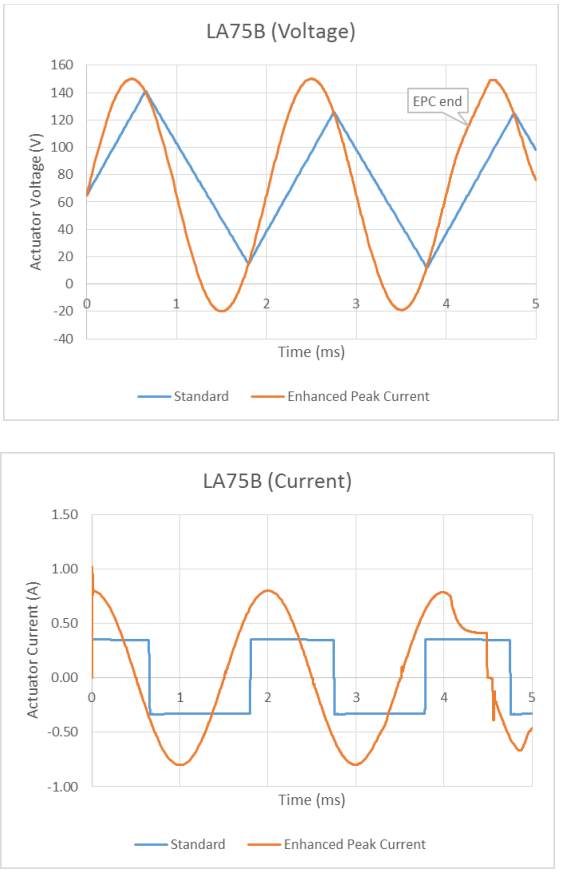

Figure 6: Actuator's voltage and current with and without peak current capability