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FURTHER RESULTS ON THE EXPONENTIAL STABILITY CRITERIA FOR TIME DELAY SINGULAR SYSTEMS WITH DELAY-DEPENDENCE

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Abstract. *The problem of delay-dependent exponential stability is investigated for singular systems with state delay. In terms of linear matrix inequality (LMI) approach, some improved delay-dependent conditions are presented to ensure the considered system to be regular, impulse free and exponentially stable via an augmented Lyapunov functional and integral inequalities matrix. Numerical examples are given to illustrate the effectiveness and the benefits of the proposed methods. These results are shown to be less conservative than those reported in the literature.*
Keywords: Singular systems, Time-delay systems, Delay-dependent, Exponential stability, Linear matrix inequality (LMI)

1. **Introduction.** Time delay is commonly encountered in various engineering systems, such as manufacturing system, turbojet engine, telecommunication, economic system and chemical engineering system. It is generally regarded as a main source of instability and poor performance. Therefore, the study of stability problem for time-delay systems is of theoretical and practical importance [1-26]. Singular systems, which are also known as descriptor systems, semi-state-space systems and generalized state-space systems are dynamic systems whose behaviors are described by both differential equations (or difference equations) and algebraic equations. Recently, there has been a growing interest in the study of such more general class of delay singular systems [1-3,5,9,10,14,22,25], and singularly perturbed systems [20,21,24] and the references therein. The existing stability criteria for singular time-delay systems can be classified into two types: delay-independent [25] and delay-dependent [2,3,6-9,19,22,23,26]. Generally, delay-dependent conditions are less conservative than the delay-dependent ones, especially when the time delay is small. It should be pointed out that the stability problem for singular systems is much more complicated than that for regular systems because it requires to consider not only stability, but also regularity and absence of impulses (for continuous singular systems) or causality (for discrete singular systems) simultaneously, while the latter two do not arise in the regular ones [5].

All of the above-mentioned stability conditions for time-delay systems are concerned with asymptotic stability instead of exponential ones. But it is very important to estimate the decay rates (i.e., exponential stability degrees) of time-delay systems in many dynamical systems. The issue of exponential stability for delay systems has received considerable attention in recent years. For example, based on the concept of matrix measure, decay rate estimates were investigated in [16], but these conditions are difficult to