Large sets of $t$-designs from $t$-homogeneous groups

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$N$ $t$-$(v, k, \lambda)$ designs with the same parameters partitioning the set of all $k$-element subsets of a set of size $v$ form a large set $LS[N](t, k; v)$. We obtain many new large sets by combining orbits of a $t$-homogeneous group of different sizes, like $LS[10](3, 15, 60)$, $LS[714](3, 15, 60)$, and $LS[518157892](3, 15, 60)$ from 518157630 orbits of size $60 \times 59 \times 29$, 775 orbits of size $20 \times 59 \times 29$, 18 orbits of size $12 \times 59 \times 29$, and 1 orbit of size $4 \times 59 \times 29$ of $PSL(2, 59)$. Algorithmic and theoretic results yield infinitely many direct constructions that each results in infinitely many families of large sets by known recursive methods.

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