

Results for 2025 Remote Identity Validation Rally Presentation Attack Detection Track

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Use of These Data

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2025 Remote Identity Validation Rally Presentation Attack Detection Overview

The 2025 Remote Identity Validation Rally (RIVR) challenges industry to deliver secure, accurate, and easy-to-use remote identity validation technologies to combat identity fraud and allow users to assert their identity online. This technology is used for applying to government services, opening bank accounts, verifying social media accounts, and other purposes. RIVR evaluated the ability of systems to authenticate identity documents, assess the ‘liveness’ of selfie photos, and verify identities using selfie and document images captured with smartphones. This report provides the outcomes of the Presentation Attack Detection (PAD) track in RIVR.

The Presentation Attack Detection track evaluated PAD subsystems on their ability to detect presentation attacks and facilitate users. Two PAD subsystem categories were evaluated: active and passive. Active subsystems allowed for direct user interaction, while passive subsystems processed images or videos captured beforehand. Effectiveness was evaluated using multiple metrics,

including Bona Fide Presentation Classification Error Rate (BPCER), Attack Presentation Classification Error Rate (APCER), and efficiency. BPCER measures the proportion of bona fide, or legitimate, presentations incorrectly flagged as attacks, while APCER measures the proportion of attack presentations misclassified as bona fide. User satisfaction was assessed for active PAD subsystems only. Multiple presentation attack species, or attack form factors, were used. The species were grouped into three different attack classes: A, B, and C, representing attacks of increasing sophistication. In these results, the maximum APCER value among species within each class, or $APCER_{Class}$, is reported. For further information about the 2025 Remote Identity Validation Rally results and test design, please visit <https://mdtf.org>.

Select results are available below. To comply with information sharing agreements between DHS and the PAD subsystem providers, all company names are aliased. If you are interested in contacting one or more of the companies that participated in RIVR, please send an e-mail to peoplescreening@hq.dhs.gov and specify the aliased systems of interest.

Data Description

- **PAD Subsystem:** Aliased presentation attack detection subsystem.
- **Time:** Average transaction time for active subsystems or average run time for passive subsystems (bona fide only).
- **Device:** Smartphone operating system (active PAD subsystems) or smartphone model (passive PAD subsystems) used in presentations.
- **Presentations:** Number of presentations to the PAD subsystem. Due to subsystem instability and variation in volunteer behavior during the data collection, some volunteers did not perform a valid transaction with all devices, creating variation in the "Presentations" count.
- **Positive Ratings:** Number of "Very Happy" and "Happy" ratings on a four button kiosk immediately after use of an active PAD subsystem (bona fide only).
- **Positive Satisfaction:** Proportion of presentations with a positive rating for active subsystems (bona fide only).
- **Category:** Demographic category. Overall is all presentations together, not disaggregated by demographic. Skin Tone is measured lightness values divided into tertiles. Age Group and Sex are based on self-report.
- **Group:** Demographic group within a demographic category.
- **Bona Fide Presentation Classification Error (BPCE):** Count of errors where a bona fide presentation was incorrectly classified as an attack presentation.
- **Bona Fide Presentation Classification Error Rate (BPCER):** Proportion of bona fide presentations incorrectly classified as attacks.
- **Attack Presentation Classification Error (APCE):** Count of errors where an attack presentation was incorrectly classified as a bona fide presentation.
- **Attack Presentation Classification Error Rate (APCER):** Proportion of attack presentations incorrectly classified as bona fide. APCER values presented here are $APCER_{Class}$ or the maximum APCER across all PAI species of a given class.

Active PAD Efficiency

Average transaction time for active subsystems (bona fide only).

PAD Subsystem	Android Time (s)	iOS Time (s)
PAD-A1	20.607	20.404
PAD-A2	18.106	18.041
PAD-A3	22.520	20.804
PAD-A4	23.023	22.363
PAD-A5	22.965	22.850
PAD-A6	23.070	20.398

Passive PAD Efficiency

Average run time for passive subsystems (bona fide only).

PAD Subsystem	iPhone 14 Base Time (s)	Google Pixel 7 Time (s)	Samsung Galaxy S22 Time (s)
PAD-P1	2.149	2.169	2.251
PAD-P2	1.704	1.830	2.169
PAD-P3	2.526	2.656	2.818
PAD-P4	6.860	7.230	7.371
PAD-P5	2.402	2.425	2.519
PAD-P6	0.804	0.820	0.773
PAD-P7	0.580	0.615	0.721
PAD-P8	0.309	0.317	0.380
PAD-P9	2.291	2.297	2.346
PAD-P10	1.514	1.517	1.600
PAD-P11	1.199	1.195	1.283
PAD-P12	0.207	0.233	0.331

Active PAD Satisfaction

Average positive satisfaction for active subsystems (bona fide only).

PAD Subsystem	Device	Positive Ratings	Presentations	Positive Satisfaction
PAD-A1	Android	617	640	0.964
PAD-A1	iOS	615	643	0.956
PAD-A2	Android	626	640	0.978
PAD-A2	iOS	591	614	0.963
PAD-A3	Android	613	642	0.955

PAD Subsystem	Device	Positive Ratings	Presentations	Positive Satisfaction
PAD-A3	iOS	618	641	0.964
PAD-A4	Android	607	641	0.947
PAD-A4	iOS	463	510	0.908
PAD-A5	Android	593	641	0.925
PAD-A5	iOS	600	642	0.935
PAD-A6	Android	564	640	0.881
PAD-A6	iOS	576	642	0.897

Active PAD Bona fide Presentation Classification Error Rate

BPCER for active subsystems by demographic group.

PAD Subsystem	Category	Group	Device	BPCEs	Presentations	BPCER
PAD-A1	Overall	Overall	Android	21	644	0.033
PAD-A1	Overall	Overall	iOS	20	644	0.031
PAD-A1	Age Group	18-45	Android	8	310	0.026
PAD-A1	Age Group	18-45	iOS	2	310	0.006
PAD-A1	Age Group	46+	Android	13	334	0.039
PAD-A1	Age Group	46+	iOS	18	334	0.054
PAD-A1	Sex	Female	Android	7	339	0.021
PAD-A1	Sex	Female	iOS	6	339	0.018
PAD-A1	Sex	Male	Android	14	303	0.046
PAD-A1	Sex	Male	iOS	14	303	0.046
PAD-A1	Race	Black or AA	Android	4	277	0.014
PAD-A1	Race	Black or AA	iOS	2	277	0.007
PAD-A1	Race	White	Android	10	201	0.050
PAD-A1	Race	White	iOS	10	201	0.050
PAD-A1	Skin Tone	T1	Android	5	213	0.023
PAD-A1	Skin Tone	T1	iOS	4	213	0.019
PAD-A1	Skin Tone	T3	Android	12	215	0.056
PAD-A1	Skin Tone	T3	iOS	11	215	0.051
PAD-A2	Overall	Overall	Android	22	644	0.034
PAD-A2	Overall	Overall	iOS	37	615	0.060
PAD-A2	Age Group	18-45	Android	3	310	0.010
PAD-A2	Age Group	18-45	iOS	10	295	0.034
PAD-A2	Age Group	46+	Android	19	334	0.057
PAD-A2	Age Group	46+	iOS	27	320	0.084
PAD-A2	Sex	Female	Android	9	339	0.027
PAD-A2	Sex	Female	iOS	16	324	0.049

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-A2	Sex	Male	Android	13	303	0.043
PAD-A2	Sex	Male	iOS	21	290	0.072
PAD-A2	Race	Black or AA	Android	11	277	0.040
PAD-A2	Race	Black or AA	iOS	11	267	0.041
PAD-A2	Race	White	Android	5	201	0.025
PAD-A2	Race	White	iOS	16	195	0.082
PAD-A2	Skin Tone	T1	Android	8	213	0.038
PAD-A2	Skin Tone	T1	iOS	11	201	0.055
PAD-A2	Skin Tone	T3	Android	6	215	0.028
PAD-A2	Skin Tone	T3	iOS	15	205	0.073
PAD-A3	Overall	Overall	Android	60	644	0.093
PAD-A3	Overall	Overall	iOS	56	644	0.087
PAD-A3	Age Group	18-45	Android	14	310	0.045
PAD-A3	Age Group	18-45	iOS	17	310	0.055
PAD-A3	Age Group	46+	Android	46	334	0.138
PAD-A3	Age Group	46+	iOS	39	334	0.117
PAD-A3	Sex	Female	Android	21	339	0.062
PAD-A3	Sex	Female	iOS	28	339	0.083
PAD-A3	Sex	Male	Android	38	303	0.125
PAD-A3	Sex	Male	iOS	27	303	0.089
PAD-A3	Race	Black or AA	Android	30	277	0.108
PAD-A3	Race	Black or AA	iOS	20	277	0.072
PAD-A3	Race	White	Android	17	201	0.085
PAD-A3	Race	White	iOS	19	201	0.095
PAD-A3	Skin Tone	T1	Android	32	213	0.150
PAD-A3	Skin Tone	T1	iOS	18	213	0.085
PAD-A3	Skin Tone	T3	Android	20	215	0.093
PAD-A3	Skin Tone	T3	iOS	20	215	0.093
PAD-A4	Overall	Overall	Android	24	644	0.037
PAD-A4	Overall	Overall	iOS	33	513	0.064
PAD-A4	Age Group	18-45	Android	10	310	0.032
PAD-A4	Age Group	18-45	iOS	11	247	0.045
PAD-A4	Age Group	46+	Android	14	334	0.042
PAD-A4	Age Group	46+	iOS	22	266	0.083
PAD-A4	Sex	Female	Android	9	339	0.027
PAD-A4	Sex	Female	iOS	15	272	0.055
PAD-A4	Sex	Male	Android	15	303	0.050
PAD-A4	Sex	Male	iOS	17	239	0.071
PAD-A4	Race	Black or AA	Android	8	277	0.029

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-A4	Race	Black or AA	iOS	15	215	0.070
PAD-A4	Race	White	Android	11	201	0.055
PAD-A4	Race	White	iOS	11	159	0.069
PAD-A4	Skin Tone	T1	Android	6	213	0.028
PAD-A4	Skin Tone	T1	iOS	12	160	0.075
PAD-A4	Skin Tone	T3	Android	11	215	0.051
PAD-A4	Skin Tone	T3	iOS	12	174	0.069
PAD-A5	Overall	Overall	Android	31	644	0.048
PAD-A5	Overall	Overall	iOS	20	644	0.031
PAD-A5	Age Group	18-45	Android	9	310	0.029
PAD-A5	Age Group	18-45	iOS	10	310	0.032
PAD-A5	Age Group	46+	Android	22	334	0.066
PAD-A5	Age Group	46+	iOS	10	334	0.030
PAD-A5	Sex	Female	Android	13	339	0.038
PAD-A5	Sex	Female	iOS	9	339	0.027
PAD-A5	Sex	Male	Android	17	303	0.056
PAD-A5	Sex	Male	iOS	11	303	0.036
PAD-A5	Race	Black or AA	Android	11	277	0.040
PAD-A5	Race	Black or AA	iOS	8	277	0.029
PAD-A5	Race	White	Android	10	201	0.050
PAD-A5	Race	White	iOS	8	201	0.040
PAD-A5	Skin Tone	T1	Android	12	213	0.056
PAD-A5	Skin Tone	T1	iOS	7	213	0.033
PAD-A5	Skin Tone	T3	Android	13	215	0.060
PAD-A5	Skin Tone	T3	iOS	9	215	0.042
PAD-A6	Overall	Overall	Android	18	644	0.028
PAD-A6	Overall	Overall	iOS	62	644	0.096
PAD-A6	Age Group	18-45	Android	9	310	0.029
PAD-A6	Age Group	18-45	iOS	29	310	0.094
PAD-A6	Age Group	46+	Android	9	334	0.027
PAD-A6	Age Group	46+	iOS	33	334	0.099
PAD-A6	Sex	Female	Android	7	339	0.021
PAD-A6	Sex	Female	iOS	23	339	0.068
PAD-A6	Sex	Male	Android	11	303	0.036
PAD-A6	Sex	Male	iOS	39	303	0.129
PAD-A6	Race	Black or AA	Android	13	277	0.047
PAD-A6	Race	Black or AA	iOS	31	277	0.112
PAD-A6	Race	White	Android	0	201	0.000
PAD-A6	Race	White	iOS	13	201	0.065

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-A6	Skin Tone	T1	Android	13	213	0.061
PAD-A6	Skin Tone	T1	iOS	34	213	0.160
PAD-A6	Skin Tone	T3	Android	2	215	0.009
PAD-A6	Skin Tone	T3	iOS	12	215	0.056

Passive PAD Bona fide Presentation Classification Error Rate

BPCER for passive subsystems by demographic group.

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P1	Overall	Overall	iPhone 14 Base	11	645	0.017
PAD-P1	Overall	Overall	Google Pixel 7	8	645	0.012
PAD-P1	Overall	Overall	Samsung Galaxy S22	3	645	0.005
PAD-P1	Age Group	18-45	iPhone 14 Base	8	311	0.026
PAD-P1	Age Group	18-45	Google Pixel 7	6	311	0.019
PAD-P1	Age Group	18-45	Samsung Galaxy S22	1	311	0.003
PAD-P1	Age Group	46+	iPhone 14 Base	3	334	0.009
PAD-P1	Age Group	46+	Google Pixel 7	2	334	0.006
PAD-P1	Age Group	46+	Samsung Galaxy S22	2	334	0.006
PAD-P1	Sex	Female	iPhone 14 Base	6	339	0.018
PAD-P1	Sex	Female	Google Pixel 7	4	339	0.012
PAD-P1	Sex	Female	Samsung Galaxy S22	2	339	0.006
PAD-P1	Sex	Male	iPhone 14 Base	5	304	0.016
PAD-P1	Sex	Male	Google Pixel 7	4	304	0.013
PAD-P1	Sex	Male	Samsung Galaxy S22	1	304	0.003
PAD-P1	Race	Black or AA	iPhone 14 Base	8	278	0.029
PAD-P1	Race	Black or AA	Google Pixel 7	6	278	0.022
PAD-P1	Race	Black or AA	Samsung Galaxy S22	0	278	0.000
PAD-P1	Race	White	iPhone 14 Base	2	201	0.010
PAD-P1	Race	White	Google Pixel 7	0	201	0.000
PAD-P1	Race	White	Samsung Galaxy S22	2	201	0.010
PAD-P1	Skin Tone	T1	iPhone 14 Base	7	214	0.033
PAD-P1	Skin Tone	T1	Google Pixel 7	4	214	0.019
PAD-P1	Skin Tone	T1	Samsung Galaxy S22	0	214	0.000
PAD-P1	Skin Tone	T3	iPhone 14 Base	2	215	0.009
PAD-P1	Skin Tone	T3	Google Pixel 7	1	215	0.005
PAD-P1	Skin Tone	T3	Samsung Galaxy S22	2	215	0.009
PAD-P2	Overall	Overall	iPhone 14 Base	8	645	0.012
PAD-P2	Overall	Overall	Google Pixel 7	20	645	0.031

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P2	Overall	Overall	Samsung Galaxy S22	3	645	0.005
PAD-P2	Age Group	18-45	iPhone 14 Base	3	311	0.010
PAD-P2	Age Group	18-45	Google Pixel 7	7	311	0.023
PAD-P2	Age Group	18-45	Samsung Galaxy S22	0	311	0.000
PAD-P2	Age Group	46+	iPhone 14 Base	5	334	0.015
PAD-P2	Age Group	46+	Google Pixel 7	13	334	0.039
PAD-P2	Age Group	46+	Samsung Galaxy S22	3	334	0.009
PAD-P2	Sex	Female	iPhone 14 Base	2	339	0.006
PAD-P2	Sex	Female	Google Pixel 7	7	339	0.021
PAD-P2	Sex	Female	Samsung Galaxy S22	0	339	0.000
PAD-P2	Sex	Male	iPhone 14 Base	6	304	0.020
PAD-P2	Sex	Male	Google Pixel 7	13	304	0.043
PAD-P2	Sex	Male	Samsung Galaxy S22	3	304	0.010
PAD-P2	Race	Black or AA	iPhone 14 Base	1	278	0.004
PAD-P2	Race	Black or AA	Google Pixel 7	12	278	0.043
PAD-P2	Race	Black or AA	Samsung Galaxy S22	0	278	0.000
PAD-P2	Race	White	iPhone 14 Base	5	201	0.025
PAD-P2	Race	White	Google Pixel 7	7	201	0.035
PAD-P2	Race	White	Samsung Galaxy S22	2	201	0.010
PAD-P2	Skin Tone	T1	iPhone 14 Base	0	214	0.000
PAD-P2	Skin Tone	T1	Google Pixel 7	10	214	0.047
PAD-P2	Skin Tone	T1	Samsung Galaxy S22	0	214	0.000
PAD-P2	Skin Tone	T3	iPhone 14 Base	4	215	0.019
PAD-P2	Skin Tone	T3	Google Pixel 7	6	215	0.028
PAD-P2	Skin Tone	T3	Samsung Galaxy S22	3	215	0.014
PAD-P3	Overall	Overall	iPhone 14 Base	103	645	0.160
PAD-P3	Overall	Overall	Google Pixel 7	54	645	0.084
PAD-P3	Overall	Overall	Samsung Galaxy S22	28	645	0.043
PAD-P3	Age Group	18-45	iPhone 14 Base	54	311	0.174
PAD-P3	Age Group	18-45	Google Pixel 7	26	311	0.084
PAD-P3	Age Group	18-45	Samsung Galaxy S22	11	311	0.035
PAD-P3	Age Group	46+	iPhone 14 Base	49	334	0.147
PAD-P3	Age Group	46+	Google Pixel 7	28	334	0.084
PAD-P3	Age Group	46+	Samsung Galaxy S22	17	334	0.051
PAD-P3	Sex	Female	iPhone 14 Base	46	339	0.136
PAD-P3	Sex	Female	Google Pixel 7	31	339	0.091
PAD-P3	Sex	Female	Samsung Galaxy S22	14	339	0.041
PAD-P3	Sex	Male	iPhone 14 Base	56	304	0.184
PAD-P3	Sex	Male	Google Pixel 7	23	304	0.076

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P3	Sex	Male	Samsung Galaxy S22	14	304	0.046
PAD-P3	Race	Black or AA	iPhone 14 Base	55	278	0.198
PAD-P3	Race	Black or AA	Google Pixel 7	27	278	0.097
PAD-P3	Race	Black or AA	Samsung Galaxy S22	12	278	0.043
PAD-P3	Race	White	iPhone 14 Base	20	201	0.100
PAD-P3	Race	White	Google Pixel 7	14	201	0.070
PAD-P3	Race	White	Samsung Galaxy S22	9	201	0.045
PAD-P3	Skin Tone	T1	iPhone 14 Base	49	214	0.229
PAD-P3	Skin Tone	T1	Google Pixel 7	20	214	0.093
PAD-P3	Skin Tone	T1	Samsung Galaxy S22	11	214	0.051
PAD-P3	Skin Tone	T3	iPhone 14 Base	21	215	0.098
PAD-P3	Skin Tone	T3	Google Pixel 7	16	215	0.074
PAD-P3	Skin Tone	T3	Samsung Galaxy S22	8	215	0.037
PAD-P4	Overall	Overall	iPhone 14 Base	109	645	0.169
PAD-P4	Overall	Overall	Google Pixel 7	86	645	0.133
PAD-P4	Overall	Overall	Samsung Galaxy S22	97	645	0.150
PAD-P4	Age Group	18-45	iPhone 14 Base	48	311	0.154
PAD-P4	Age Group	18-45	Google Pixel 7	32	311	0.103
PAD-P4	Age Group	18-45	Samsung Galaxy S22	46	311	0.148
PAD-P4	Age Group	46+	iPhone 14 Base	61	334	0.183
PAD-P4	Age Group	46+	Google Pixel 7	54	334	0.162
PAD-P4	Age Group	46+	Samsung Galaxy S22	51	334	0.153
PAD-P4	Sex	Female	iPhone 14 Base	20	339	0.059
PAD-P4	Sex	Female	Google Pixel 7	26	339	0.077
PAD-P4	Sex	Female	Samsung Galaxy S22	17	339	0.050
PAD-P4	Sex	Male	iPhone 14 Base	89	304	0.293
PAD-P4	Sex	Male	Google Pixel 7	59	304	0.194
PAD-P4	Sex	Male	Samsung Galaxy S22	80	304	0.263
PAD-P4	Race	Black or AA	iPhone 14 Base	62	278	0.223
PAD-P4	Race	Black or AA	Google Pixel 7	44	278	0.158
PAD-P4	Race	Black or AA	Samsung Galaxy S22	43	278	0.155
PAD-P4	Race	White	iPhone 14 Base	29	201	0.144
PAD-P4	Race	White	Google Pixel 7	20	201	0.100
PAD-P4	Race	White	Samsung Galaxy S22	27	201	0.134
PAD-P4	Skin Tone	T1	iPhone 14 Base	50	214	0.234
PAD-P4	Skin Tone	T1	Google Pixel 7	35	214	0.164
PAD-P4	Skin Tone	T1	Samsung Galaxy S22	38	214	0.178
PAD-P4	Skin Tone	T3	iPhone 14 Base	25	215	0.116
PAD-P4	Skin Tone	T3	Google Pixel 7	23	215	0.107

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P4	Skin Tone	T3	Samsung Galaxy S22	30	215	0.140
PAD-P5	Overall	Overall	iPhone 14 Base	39	645	0.060
PAD-P5	Overall	Overall	Google Pixel 7	38	645	0.059
PAD-P5	Overall	Overall	Samsung Galaxy S22	14	645	0.022
PAD-P5	Age Group	18-45	iPhone 14 Base	22	311	0.071
PAD-P5	Age Group	18-45	Google Pixel 7	13	311	0.042
PAD-P5	Age Group	18-45	Samsung Galaxy S22	6	311	0.019
PAD-P5	Age Group	46+	iPhone 14 Base	17	334	0.051
PAD-P5	Age Group	46+	Google Pixel 7	25	334	0.075
PAD-P5	Age Group	46+	Samsung Galaxy S22	8	334	0.024
PAD-P5	Sex	Female	iPhone 14 Base	13	339	0.038
PAD-P5	Sex	Female	Google Pixel 7	9	339	0.027
PAD-P5	Sex	Female	Samsung Galaxy S22	5	339	0.015
PAD-P5	Sex	Male	iPhone 14 Base	26	304	0.086
PAD-P5	Sex	Male	Google Pixel 7	29	304	0.095
PAD-P5	Sex	Male	Samsung Galaxy S22	9	304	0.030
PAD-P5	Race	Black or AA	iPhone 14 Base	33	278	0.119
PAD-P5	Race	Black or AA	Google Pixel 7	35	278	0.126
PAD-P5	Race	Black or AA	Samsung Galaxy S22	8	278	0.029
PAD-P5	Race	White	iPhone 14 Base	2	201	0.010
PAD-P5	Race	White	Google Pixel 7	2	201	0.010
PAD-P5	Race	White	Samsung Galaxy S22	1	201	0.005
PAD-P5	Skin Tone	T1	iPhone 14 Base	32	214	0.150
PAD-P5	Skin Tone	T1	Google Pixel 7	31	214	0.145
PAD-P5	Skin Tone	T1	Samsung Galaxy S22	9	214	0.042
PAD-P5	Skin Tone	T3	iPhone 14 Base	3	215	0.014
PAD-P5	Skin Tone	T3	Google Pixel 7	2	215	0.009
PAD-P5	Skin Tone	T3	Samsung Galaxy S22	1	215	0.005
PAD-P6	Overall	Overall	iPhone 14 Base	1	645	0.002
PAD-P6	Overall	Overall	Google Pixel 7	2	645	0.003
PAD-P6	Overall	Overall	Samsung Galaxy S22	0	645	0.000
PAD-P6	Age Group	18-45	iPhone 14 Base	1	311	0.003
PAD-P6	Age Group	18-45	Google Pixel 7	2	311	0.006
PAD-P6	Age Group	18-45	Samsung Galaxy S22	0	311	0.000
PAD-P6	Age Group	46+	iPhone 14 Base	0	334	0.000
PAD-P6	Age Group	46+	Google Pixel 7	0	334	0.000
PAD-P6	Age Group	46+	Samsung Galaxy S22	0	334	0.000
PAD-P6	Sex	Female	iPhone 14 Base	0	339	0.000
PAD-P6	Sex	Female	Google Pixel 7	2	339	0.006

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P6	Sex	Female	Samsung Galaxy S22	0	339	0.000
PAD-P6	Sex	Male	iPhone 14 Base	1	304	0.003
PAD-P6	Sex	Male	Google Pixel 7	0	304	0.000
PAD-P6	Sex	Male	Samsung Galaxy S22	0	304	0.000
PAD-P6	Race	Black or AA	iPhone 14 Base	0	278	0.000
PAD-P6	Race	Black or AA	Google Pixel 7	2	278	0.007
PAD-P6	Race	Black or AA	Samsung Galaxy S22	0	278	0.000
PAD-P6	Race	White	iPhone 14 Base	0	201	0.000
PAD-P6	Race	White	Google Pixel 7	0	201	0.000
PAD-P6	Race	White	Samsung Galaxy S22	0	201	0.000
PAD-P6	Skin Tone	T1	iPhone 14 Base	0	214	0.000
PAD-P6	Skin Tone	T1	Google Pixel 7	2	214	0.009
PAD-P6	Skin Tone	T1	Samsung Galaxy S22	0	214	0.000
PAD-P6	Skin Tone	T3	iPhone 14 Base	0	215	0.000
PAD-P6	Skin Tone	T3	Google Pixel 7	0	215	0.000
PAD-P6	Skin Tone	T3	Samsung Galaxy S22	0	215	0.000
PAD-P7	Overall	Overall	iPhone 14 Base	372	645	0.577
PAD-P7	Overall	Overall	Google Pixel 7	307	645	0.476
PAD-P7	Overall	Overall	Samsung Galaxy S22	359	645	0.557
PAD-P7	Age Group	18-45	iPhone 14 Base	158	311	0.508
PAD-P7	Age Group	18-45	Google Pixel 7	131	311	0.421
PAD-P7	Age Group	18-45	Samsung Galaxy S22	157	311	0.505
PAD-P7	Age Group	46+	iPhone 14 Base	214	334	0.641
PAD-P7	Age Group	46+	Google Pixel 7	176	334	0.527
PAD-P7	Age Group	46+	Samsung Galaxy S22	202	334	0.605
PAD-P7	Sex	Female	iPhone 14 Base	168	339	0.496
PAD-P7	Sex	Female	Google Pixel 7	133	339	0.392
PAD-P7	Sex	Female	Samsung Galaxy S22	154	339	0.454
PAD-P7	Sex	Male	iPhone 14 Base	204	304	0.671
PAD-P7	Sex	Male	Google Pixel 7	174	304	0.572
PAD-P7	Sex	Male	Samsung Galaxy S22	205	304	0.674
PAD-P7	Race	Black or AA	iPhone 14 Base	156	278	0.561
PAD-P7	Race	Black or AA	Google Pixel 7	143	278	0.514
PAD-P7	Race	Black or AA	Samsung Galaxy S22	157	278	0.565
PAD-P7	Race	White	iPhone 14 Base	130	201	0.647
PAD-P7	Race	White	Google Pixel 7	96	201	0.478
PAD-P7	Race	White	Samsung Galaxy S22	123	201	0.612
PAD-P7	Skin Tone	T1	iPhone 14 Base	129	214	0.603
PAD-P7	Skin Tone	T1	Google Pixel 7	115	214	0.537

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P7	Skin Tone	T1	Samsung Galaxy S22	132	214	0.617
PAD-P7	Skin Tone	T3	iPhone 14 Base	125	215	0.581
PAD-P7	Skin Tone	T3	Google Pixel 7	89	215	0.414
PAD-P7	Skin Tone	T3	Samsung Galaxy S22	120	215	0.558
PAD-P8	Overall	Overall	iPhone 14 Base	20	645	0.031
PAD-P8	Overall	Overall	Google Pixel 7	17	645	0.026
PAD-P8	Overall	Overall	Samsung Galaxy S22	8	645	0.012
PAD-P8	Age Group	18-45	iPhone 14 Base	13	311	0.042
PAD-P8	Age Group	18-45	Google Pixel 7	13	311	0.042
PAD-P8	Age Group	18-45	Samsung Galaxy S22	5	311	0.016
PAD-P8	Age Group	46+	iPhone 14 Base	7	334	0.021
PAD-P8	Age Group	46+	Google Pixel 7	4	334	0.012
PAD-P8	Age Group	46+	Samsung Galaxy S22	3	334	0.009
PAD-P8	Sex	Female	iPhone 14 Base	6	339	0.018
PAD-P8	Sex	Female	Google Pixel 7	4	339	0.012
PAD-P8	Sex	Female	Samsung Galaxy S22	1	339	0.003
PAD-P8	Sex	Male	iPhone 14 Base	14	304	0.046
PAD-P8	Sex	Male	Google Pixel 7	13	304	0.043
PAD-P8	Sex	Male	Samsung Galaxy S22	7	304	0.023
PAD-P8	Race	Black or AA	iPhone 14 Base	12	278	0.043
PAD-P8	Race	Black or AA	Google Pixel 7	14	278	0.050
PAD-P8	Race	Black or AA	Samsung Galaxy S22	6	278	0.022
PAD-P8	Race	White	iPhone 14 Base	4	201	0.020
PAD-P8	Race	White	Google Pixel 7	0	201	0.000
PAD-P8	Race	White	Samsung Galaxy S22	2	201	0.010
PAD-P8	Skin Tone	T1	iPhone 14 Base	11	214	0.051
PAD-P8	Skin Tone	T1	Google Pixel 7	13	214	0.061
PAD-P8	Skin Tone	T1	Samsung Galaxy S22	6	214	0.028
PAD-P8	Skin Tone	T3	iPhone 14 Base	4	215	0.019
PAD-P8	Skin Tone	T3	Google Pixel 7	1	215	0.005
PAD-P8	Skin Tone	T3	Samsung Galaxy S22	1	215	0.005
PAD-P9	Overall	Overall	iPhone 14 Base	3	645	0.005
PAD-P9	Overall	Overall	Google Pixel 7	2	645	0.003
PAD-P9	Overall	Overall	Samsung Galaxy S22	0	645	0.000
PAD-P9	Age Group	18-45	iPhone 14 Base	2	311	0.006
PAD-P9	Age Group	18-45	Google Pixel 7	1	311	0.003
PAD-P9	Age Group	18-45	Samsung Galaxy S22	0	311	0.000
PAD-P9	Age Group	46+	iPhone 14 Base	1	334	0.003
PAD-P9	Age Group	46+	Google Pixel 7	1	334	0.003

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P9	Age Group	46+	Samsung Galaxy S22	0	334	0.000
PAD-P9	Sex	Female	iPhone 14 Base	2	339	0.006
PAD-P9	Sex	Female	Google Pixel 7	2	339	0.006
PAD-P9	Sex	Female	Samsung Galaxy S22	0	339	0.000
PAD-P9	Sex	Male	iPhone 14 Base	1	304	0.003
PAD-P9	Sex	Male	Google Pixel 7	0	304	0.000
PAD-P9	Sex	Male	Samsung Galaxy S22	0	304	0.000
PAD-P9	Race	Black or AA	iPhone 14 Base	0	278	0.000
PAD-P9	Race	Black or AA	Google Pixel 7	0	278	0.000
PAD-P9	Race	Black or AA	Samsung Galaxy S22	0	278	0.000
PAD-P9	Race	White	iPhone 14 Base	2	201	0.010
PAD-P9	Race	White	Google Pixel 7	1	201	0.005
PAD-P9	Race	White	Samsung Galaxy S22	0	201	0.000
PAD-P9	Skin Tone	T1	iPhone 14 Base	0	214	0.000
PAD-P9	Skin Tone	T1	Google Pixel 7	0	214	0.000
PAD-P9	Skin Tone	T1	Samsung Galaxy S22	0	214	0.000
PAD-P9	Skin Tone	T3	iPhone 14 Base	3	215	0.014
PAD-P9	Skin Tone	T3	Google Pixel 7	2	215	0.009
PAD-P9	Skin Tone	T3	Samsung Galaxy S22	0	215	0.000
PAD-P10	Overall	Overall	iPhone 14 Base	11	645	0.017
PAD-P10	Overall	Overall	Google Pixel 7	16	645	0.025
PAD-P10	Overall	Overall	Samsung Galaxy S22	8	645	0.012
PAD-P10	Age Group	18-45	iPhone 14 Base	1	311	0.003
PAD-P10	Age Group	18-45	Google Pixel 7	6	311	0.019
PAD-P10	Age Group	18-45	Samsung Galaxy S22	1	311	0.003
PAD-P10	Age Group	46+	iPhone 14 Base	10	334	0.030
PAD-P10	Age Group	46+	Google Pixel 7	10	334	0.030
PAD-P10	Age Group	46+	Samsung Galaxy S22	7	334	0.021
PAD-P10	Sex	Female	iPhone 14 Base	4	339	0.012
PAD-P10	Sex	Female	Google Pixel 7	3	339	0.009
PAD-P10	Sex	Female	Samsung Galaxy S22	2	339	0.006
PAD-P10	Sex	Male	iPhone 14 Base	6	304	0.020
PAD-P10	Sex	Male	Google Pixel 7	12	304	0.039
PAD-P10	Sex	Male	Samsung Galaxy S22	5	304	0.016
PAD-P10	Race	Black or AA	iPhone 14 Base	5	278	0.018
PAD-P10	Race	Black or AA	Google Pixel 7	7	278	0.025
PAD-P10	Race	Black or AA	Samsung Galaxy S22	5	278	0.018
PAD-P10	Race	White	iPhone 14 Base	2	201	0.010
PAD-P10	Race	White	Google Pixel 7	5	201	0.025

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P10	Race	White	Samsung Galaxy S22	2	201	0.010
PAD-P10	Skin Tone	T1	iPhone 14 Base	5	214	0.023
PAD-P10	Skin Tone	T1	Google Pixel 7	6	214	0.028
PAD-P10	Skin Tone	T1	Samsung Galaxy S22	5	214	0.023
PAD-P10	Skin Tone	T3	iPhone 14 Base	4	215	0.019
PAD-P10	Skin Tone	T3	Google Pixel 7	5	215	0.023
PAD-P10	Skin Tone	T3	Samsung Galaxy S22	2	215	0.009
PAD-P11	Overall	Overall	iPhone 14 Base	11	645	0.017
PAD-P11	Overall	Overall	Google Pixel 7	18	645	0.028
PAD-P11	Overall	Overall	Samsung Galaxy S22	8	645	0.012
PAD-P11	Age Group	18-45	iPhone 14 Base	4	311	0.013
PAD-P11	Age Group	18-45	Google Pixel 7	6	311	0.019
PAD-P11	Age Group	18-45	Samsung Galaxy S22	2	311	0.006
PAD-P11	Age Group	46+	iPhone 14 Base	7	334	0.021
PAD-P11	Age Group	46+	Google Pixel 7	12	334	0.036
PAD-P11	Age Group	46+	Samsung Galaxy S22	6	334	0.018
PAD-P11	Sex	Female	iPhone 14 Base	7	339	0.021
PAD-P11	Sex	Female	Google Pixel 7	7	339	0.021
PAD-P11	Sex	Female	Samsung Galaxy S22	4	339	0.012
PAD-P11	Sex	Male	iPhone 14 Base	4	304	0.013
PAD-P11	Sex	Male	Google Pixel 7	11	304	0.036
PAD-P11	Sex	Male	Samsung Galaxy S22	4	304	0.013
PAD-P11	Race	Black or AA	iPhone 14 Base	2	278	0.007
PAD-P11	Race	Black or AA	Google Pixel 7	9	278	0.032
PAD-P11	Race	Black or AA	Samsung Galaxy S22	4	278	0.014
PAD-P11	Race	White	iPhone 14 Base	4	201	0.020
PAD-P11	Race	White	Google Pixel 7	4	201	0.020
PAD-P11	Race	White	Samsung Galaxy S22	1	201	0.005
PAD-P11	Skin Tone	T1	iPhone 14 Base	2	214	0.009
PAD-P11	Skin Tone	T1	Google Pixel 7	7	214	0.033
PAD-P11	Skin Tone	T1	Samsung Galaxy S22	6	214	0.028
PAD-P11	Skin Tone	T3	iPhone 14 Base	7	215	0.033
PAD-P11	Skin Tone	T3	Google Pixel 7	2	215	0.009
PAD-P11	Skin Tone	T3	Samsung Galaxy S22	1	215	0.005
PAD-P12	Overall	Overall	iPhone 14 Base	5	645	0.008
PAD-P12	Overall	Overall	Google Pixel 7	5	645	0.008
PAD-P12	Overall	Overall	Samsung Galaxy S22	2	645	0.003
PAD-P12	Age Group	18-45	iPhone 14 Base	4	311	0.013
PAD-P12	Age Group	18-45	Google Pixel 7	3	311	0.010

PAD Subsystem	Category	Group	Device	BPCes	Presentations	BPCER
PAD-P12	Age Group	18-45	Samsung Galaxy S22	1	311	0.003
PAD-P12	Age Group	46+	iPhone 14 Base	1	334	0.003
PAD-P12	Age Group	46+	Google Pixel 7	2	334	0.006
PAD-P12	Age Group	46+	Samsung Galaxy S22	1	334	0.003
PAD-P12	Sex	Female	iPhone 14 Base	1	339	0.003
PAD-P12	Sex	Female	Google Pixel 7	1	339	0.003
PAD-P12	Sex	Female	Samsung Galaxy S22	0	339	0.000
PAD-P12	Sex	Male	iPhone 14 Base	4	304	0.013
PAD-P12	Sex	Male	Google Pixel 7	4	304	0.013
PAD-P12	Sex	Male	Samsung Galaxy S22	2	304	0.007
PAD-P12	Race	Black or AA	iPhone 14 Base	3	278	0.011
PAD-P12	Race	Black or AA	Google Pixel 7	3	278	0.011
PAD-P12	Race	Black or AA	Samsung Galaxy S22	1	278	0.004
PAD-P12	Race	White	iPhone 14 Base	1	201	0.005
PAD-P12	Race	White	Google Pixel 7	1	201	0.005
PAD-P12	Race	White	Samsung Galaxy S22	1	201	0.005
PAD-P12	Skin Tone	T1	iPhone 14 Base	1	214	0.005
PAD-P12	Skin Tone	T1	Google Pixel 7	1	214	0.005
PAD-P12	Skin Tone	T1	Samsung Galaxy S22	0	214	0.000
PAD-P12	Skin Tone	T3	iPhone 14 Base	2	215	0.009
PAD-P12	Skin Tone	T3	Google Pixel 7	2	215	0.009
PAD-P12	Skin Tone	T3	Samsung Galaxy S22	1	215	0.005

Active PAD Attack Presentation Classification Error Rate Class

$APCER_{Class}$ for active subsystems.

PAD Subsystem	Device	Class	APCER
PAD-A1	Android	A	0.000
PAD-A1	iOS	A	0.000
PAD-A1	Android	B	0.000
PAD-A1	iOS	B	0.000
PAD-A1	Android	C	0.067
PAD-A1	iOS	C	0.133
PAD-A2	Android	A	0.000
PAD-A2	iOS	A	0.000
PAD-A2	Android	B	0.000
PAD-A2	iOS	B	0.000
PAD-A2	Android	C	0.000

PAD Subsystem	Device	Class	APCER
PAD-A2	iOS	C	0.000
PAD-A3	Android	A	0.233
PAD-A3	iOS	A	0.083
PAD-A3	Android	B	0.017
PAD-A3	iOS	B	0.033
PAD-A3	Android	C	0.000
PAD-A3	iOS	C	0.017
PAD-A4	Android	A	0.017
PAD-A4	iOS	A	0.000
PAD-A4	Android	B	0.000
PAD-A4	iOS	B	0.000
PAD-A4	Android	C	0.017
PAD-A4	iOS	C	0.000
PAD-A5	Android	A	0.033
PAD-A5	iOS	A	0.017
PAD-A5	Android	B	0.000
PAD-A5	iOS	B	0.017
PAD-A5	Android	C	0.000
PAD-A5	iOS	C	0.017
PAD-A6	Android	A	0.650
PAD-A6	iOS	A	0.283
PAD-A6	Android	B	0.333
PAD-A6	iOS	B	0.417
PAD-A6	Android	C	0.233
PAD-A6	iOS	C	0.267

Passive PAD Attack Presentation Classification Error Rate Class

$APCER_{Class}$ for passive subsystems.

PAD Subsystem	Device	Class	APCER
PAD-P1	iPhone 14 Base	A	0.133
PAD-P1	Google Pixel 7	A	0.133
PAD-P1	Samsung Galaxy S22	A	0.100
PAD-P1	iPhone 14 Base	B	0.000
PAD-P1	Google Pixel 7	B	0.067
PAD-P1	Samsung Galaxy S22	B	0.000
PAD-P1	iPhone 14 Base	C	0.033
PAD-P1	Google Pixel 7	C	0.017

PAD Subsystem	Device	Class	APCER
PAD-P1	Samsung Galaxy S22	C	0.000
PAD-P2	iPhone 14 Base	A	0.383
PAD-P2	Google Pixel 7	A	0.517
PAD-P2	Samsung Galaxy S22	A	0.350
PAD-P2	iPhone 14 Base	B	0.067
PAD-P2	Google Pixel 7	B	0.117
PAD-P2	Samsung Galaxy S22	B	0.050
PAD-P2	iPhone 14 Base	C	0.000
PAD-P2	Google Pixel 7	C	0.000
PAD-P2	Samsung Galaxy S22	C	0.000
PAD-P3	iPhone 14 Base	A	0.733
PAD-P3	Google Pixel 7	A	0.733
PAD-P3	Samsung Galaxy S22	A	0.783
PAD-P3	iPhone 14 Base	B	0.817
PAD-P3	Google Pixel 7	B	0.967
PAD-P3	Samsung Galaxy S22	B	0.850
PAD-P3	iPhone 14 Base	C	0.450
PAD-P3	Google Pixel 7	C	0.350
PAD-P3	Samsung Galaxy S22	C	0.283
PAD-P4	iPhone 14 Base	A	0.100
PAD-P4	Google Pixel 7	A	0.167
PAD-P4	Samsung Galaxy S22	A	0.033
PAD-P4	iPhone 14 Base	B	0.050
PAD-P4	Google Pixel 7	B	0.033
PAD-P4	Samsung Galaxy S22	B	0.000
PAD-P4	iPhone 14 Base	C	0.117
PAD-P4	Google Pixel 7	C	0.083
PAD-P4	Samsung Galaxy S22	C	0.017
PAD-P5	iPhone 14 Base	A	0.517
PAD-P5	Google Pixel 7	A	0.800
PAD-P5	Samsung Galaxy S22	A	0.667
PAD-P5	iPhone 14 Base	B	0.333
PAD-P5	Google Pixel 7	B	0.467
PAD-P5	Samsung Galaxy S22	B	0.117
PAD-P5	iPhone 14 Base	C	0.183
PAD-P5	Google Pixel 7	C	0.050
PAD-P5	Samsung Galaxy S22	C	0.000
PAD-P6	iPhone 14 Base	A	0.117
PAD-P6	Google Pixel 7	A	0.267

PAD Subsystem	Device	Class	APCER
PAD-P6	Samsung Galaxy S22	A	0.217
PAD-P6	iPhone 14 Base	B	0.200
PAD-P6	Google Pixel 7	B	0.267
PAD-P6	Samsung Galaxy S22	B	0.000
PAD-P6	iPhone 14 Base	C	0.417
PAD-P6	Google Pixel 7	C	0.383
PAD-P6	Samsung Galaxy S22	C	0.400
PAD-P7	iPhone 14 Base	A	0.383
PAD-P7	Google Pixel 7	A	0.383
PAD-P7	Samsung Galaxy S22	A	0.250
PAD-P7	iPhone 14 Base	B	0.867
PAD-P7	Google Pixel 7	B	0.933
PAD-P7	Samsung Galaxy S22	B	0.967
PAD-P7	iPhone 14 Base	C	0.783
PAD-P7	Google Pixel 7	C	0.917
PAD-P7	Samsung Galaxy S22	C	0.950
PAD-P8	iPhone 14 Base	A	0.783
PAD-P8	Google Pixel 7	A	0.883
PAD-P8	Samsung Galaxy S22	A	0.750
PAD-P8	iPhone 14 Base	B	0.700
PAD-P8	Google Pixel 7	B	0.683
PAD-P8	Samsung Galaxy S22	B	0.533
PAD-P8	iPhone 14 Base	C	0.717
PAD-P8	Google Pixel 7	C	0.633
PAD-P8	Samsung Galaxy S22	C	0.783
PAD-P9	iPhone 14 Base	A	0.000
PAD-P9	Google Pixel 7	A	0.017
PAD-P9	Samsung Galaxy S22	A	0.017
PAD-P9	iPhone 14 Base	B	0.000
PAD-P9	Google Pixel 7	B	0.000
PAD-P9	Samsung Galaxy S22	B	0.000
PAD-P9	iPhone 14 Base	C	0.017
PAD-P9	Google Pixel 7	C	0.000
PAD-P9	Samsung Galaxy S22	C	0.000
PAD-P10	iPhone 14 Base	A	0.733
PAD-P10	Google Pixel 7	A	0.867
PAD-P10	Samsung Galaxy S22	A	0.733
PAD-P10	iPhone 14 Base	B	0.150
PAD-P10	Google Pixel 7	B	0.200

PAD Subsystem	Device	Class	APCER
PAD-P10	Samsung Galaxy S22	B	0.083
PAD-P10	iPhone 14 Base	C	0.217
PAD-P10	Google Pixel 7	C	0.167
PAD-P10	Samsung Galaxy S22	C	0.067
PAD-P11	iPhone 14 Base	A	0.800
PAD-P11	Google Pixel 7	A	0.600
PAD-P11	Samsung Galaxy S22	A	0.533
PAD-P11	iPhone 14 Base	B	0.767
PAD-P11	Google Pixel 7	B	0.600
PAD-P11	Samsung Galaxy S22	B	0.100
PAD-P11	iPhone 14 Base	C	0.100
PAD-P11	Google Pixel 7	C	0.050
PAD-P11	Samsung Galaxy S22	C	0.000
PAD-P12	iPhone 14 Base	A	1.000
PAD-P12	Google Pixel 7	A	1.000
PAD-P12	Samsung Galaxy S22	A	1.000
PAD-P12	iPhone 14 Base	B	1.000
PAD-P12	Google Pixel 7	B	1.000
PAD-P12	Samsung Galaxy S22	B	1.000
PAD-P12	iPhone 14 Base	C	1.000
PAD-P12	Google Pixel 7	C	1.000
PAD-P12	Samsung Galaxy S22	C	1.000