SUPPORTING INFORMATION

Table S1: Average photovoltaic performance of $MA_{0.6}FA_{0.4}PbI_3$ perovskite devices having different doping concentration of F4TCNQ dopant in FDT HTL in FB-SC direction at a scan rate of 0.05 V/s

F4TCNQ Dopant Concentration (wt%)	Open Circuit Voltage, V_{OC} (mV)	Short Circuit Current Density, J_{SC} (mA/cm^2)	Fill Factor, FF (%)	Efficiency (%)	Series Resistance, R_S (Ω.cm^2)	Shunt Resistance R_{Sh} (Ω.cm^2)
0	744.69	19.26	48.66	6.98	12.69	267
0.5	863.88	20.41	69.99	12.34	5.90	1215
1	935.64	20.54	70.87	13.63	4.62	1220
1.5	916.30	20.27	69.86	12.97	5.27	1381
2	902.85	19.90	65.05	11.69	7.34	1382

Table S2: J-V parameters (V_{OC}, J_{SC}, FF and PCE values) of ten (10) L-FDT devices in FB-SC direction from a single, random batch at a scan rate of 0.05 V/s

Sample No.	Open Circuit Voltage, V_{OC} (mV)	Short Circuit Current Density, J_{SC} (mA/cm^2)	Fill Factor, FF (%)	Efficiency (%)	Series Resistance, R_S (Ω.cm^2)	Shunt Resistance R_{Sh} (Ω.cm^2)
1	905.53	21.22	60.76	11.68	9.50	1085
2	930.89	20.03	62.13	11.58	9.36	1169
3	926.09	21.46	61.02	12.13	9.86	1134
4	942.09	20.06	60.88	11.50	10.22	1035
5	925.59	21.46	61.44	12.20	9.05	1017
6	899.92	20.72	63.77	11.89	7.79	1089
7	912.58	21.58	61.37	12.08	8.73	1130
8	915.38	21.21	61.34	11.91	9.00	1152
9	940.42	20.02	60.82	11.45	10.40	1070
10	905.25	20.95	63.44	12.03	7.83	1265

Table S3: J-V parameter**s** (V_{OC}, J_{SC}, FF and PCE values) of ten (10) F-FDT devices in FB-SC direction from a single, random batch at a scan rate of 0.05 V/s

Sample No.	Open Circuit Voltage, V_{OC} (mV)	Short Circuit Current Density, J_{SC} (mA/cm^2)	Fill Factor, FF (%)	Efficiency (%)	Series Resistance, R_S (Ω.cm^2)	Shunt Resistance R_{Sh} (Ω.cm^2)
1	944.06	20.41	70.87	13.66	4.68	1251
2	951.63	21.03	71.47	14.30	4.17	1292
3	935.38	20.65	71.45	13.80	4.32	1134
4	920.08	20.50	68.94	13.01	5.18	1247
5	944.37	20.80	71.64	14.07	4.36	1278
6	933.99	20.38	69.67	13.26	5.18	1409
7	920.74	20.33	69.87	13.08	5.18	1440
8	923.81	20.11	71.79	13.34	4.38	941
9	935.38	20.65	71.45	13.80	4.32	1134
10	946.94	20.57	71.53	13.93	4.47	1080

Table S4: Stabilized current density and PCE of L-FDT and F-FDT PSCs at maximum power point (MPP)

Device	Voltage at MPP (V)	Stabilized PCE (%)	Stabilized Current Density (mA/cm^2)
L-FDT	~0.70	~11.87	~18.35
F-FDT	~0.79	~13.33	~18.68

Table S5: Hysteresis index (HI) of L-FDT and F-FDT PSCs calculated from J-V measurements in both FB-SC and SC-FB directions at a scan rate of 0.05 V/s

Device	Current Density at ($V_{OC}/2$) in FB-SC scan (mA/cm^2)	Current Density at ($V_{OC}/2$) in SC-FB scan (mA/cm^2)	Hysteresis Index (HI)
L-FDT	20.40	18.33	0.10
F-FDT	20.96	19.49	0.07

Table S6: Day wise PCE, J_{SC}, V_{OC} and FF values of a L-FDT PSC stored in a N_2 filled glovebox for 21 days (Scan direction: FB-SC, scan rate: 0.05 V/s)

Number of Days	Open Circuit Voltage, V_{OC} (mV)	Short Circuit Current Density, J_{SC} (mA/cm^2)	Fill Factor, FF (%)	Efficiency (%)
0	940.42	20.02	60.82	11.45
1	903.40	20.08	60.29	10.94
3	917.85	19.76	59.12	10.72
5	905.87	19.70	58.47	10.44
7	891.92	20.07	54.71	9.80
9	894.88	19.57	54.13	9.48
11	882.43	19.31	53.25	9.07
13	872.93	19.20	51.70	8.66
15	839.99	18.23	50.83	7.78
17	824.97	18.19	45.44	6.82
19	785.65	17.97	44.25	6.26
21	742.27	17.88	43.77	5.81

Table S7: Day wise PCE, J_{SC}, V_{OC} and FF values of a F-FDT PSC stored in a N_2 filled glovebox for 21 days (Scan direction: FB-SC, scan rate: 0.05 V/s)

Number of Days	Open Circuit Voltage, V_{OC} (mV)	Short Circuit Current Density, J_{SC} (mA/cm^2)	Fill Factor, FF (%)	Efficiency (%)
0	951.63	21.03	71.47	14.30
1	957.89	20.73	71.69	14.24
3	944.36	20.80	71.64	14.07
5	946.94	20.56	71.53	13.93
7	948.49	20.48	71.22	13.84
9	944.06	20.41	70.87	13.66
11	925.83	20.55	71.40	13.58
13	925.81	20.48	71.15	13.49
15	910.89	20.47	70.89	13.22
17	904.94	20.55	70.66	13.14
19	893.88	20.23	70.85	12.81
21	887.07	20.54	69.88	12.73

Table S8: Values of contact angles of water droplets on L-FDT, F-FDT and pristine FDT HTL films on three different spots of respective surfaces in both left and right directions from Fig. 5(B)-5(D)

HTL Layer	Contact Angle (Spot 1) (Degree)		Contact Angle (Spot 2) (Degree)		Contact Angle (Spot 3) (Degree)		Average Contact Angle with Standard Deviation (Degree)
	Left	**Right**	**Left**	**Right**	**Left**	**Right**	
Pristine FDT	82.7	81.9	80.8	81.5	81.9	82.2	81.8±0.6
L-FDT	76.8	77.9	77.5	76.3	79.1	78.9	77.8±1.1
F-FDT	86.8	87.2	87.3	87.6	86.6	86.2	87±0.5

Table S9: Relative normalized peak intensity, peak width, microstrain and dislocation density of aged perovskite films underneath pristine FDT, L-FDT and F-FDT HTL films, calculated by the spectral fitting from XRD measurement data

Characteristic Peak	HTL Layer on perovskite	Relative Normalized Peak Intensity	Peak Width (FWHM) (Degree)	Microstrain ($x10^{-3}$)	Dislocation Density ($x10^{11}$ cm^{-3})
(110)	Pristine FDT	0.95	0.12709	4.51	0.25
	L-FDT	0.69	0.16279	5.80	0.41
	F-FDT	1.00	0.12991	4.62	0.26
(202)	Pristine FDT	0.13	0.20427	4.12	0.63
	L-FDT	0.33	0.18491	3.74	0.52
	F-FDT	0.15	0.19722	3.98	0.59
(220)	Pristine FDT	0.44	0.14953	2.60	0.33
	L-FDT	0.34	0.17234	3.00	0.44
	F-FDT	0.47	0.13917	2.41	0.29
(310)	Pristine FDT	0.33	0.14601	2.25	0.31
	L-FDT	0.22	0.17902	2.76	0.47
	F-FDT	0.33	0.15206	2.34	0.34
(224)	Pristine FDT	0.15	0.17884	2.13	0.44
	L-FDT	0.09	0.19386	2.31	0.52
	F-FDT	0.17	0.13216	1.57	0.24
(314)	Pristine FDT	0.10	0.20154	2.24	0.56
	L-FDT	0.06	0.24550	2.73	0.83
	F-FDT	0.11	0.20631	2.29	0.58

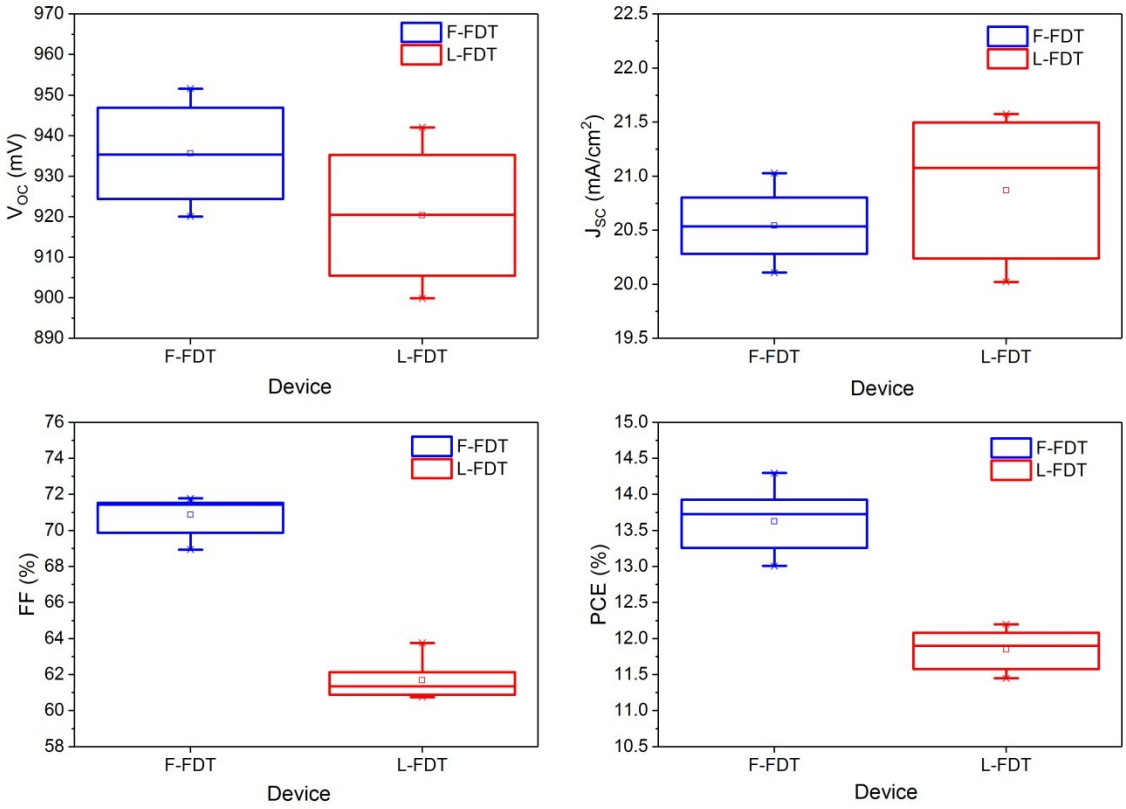

Fig. S1 Statistical box-chart showing the range of variation in (A) V_{OC}, (B) J_{SC}, (C) FF and (D) PCE in FB-SC direction obtained from ten identically fabricated L-FDT and F-FDT devices in a single, random batch at a scan rate of 0.05 V/s

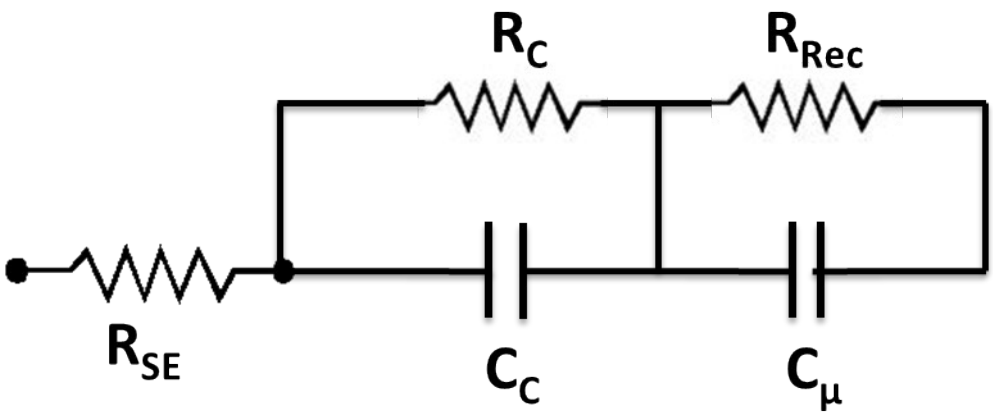

Fig. S2 Equivalent circuit model used to fit the experimental data from Nyquist plot at Fig. 2(B). The components R_S, R_C, C_C, R_{Rec} and C_μ denote the resistance originating from the wire connection and metal contact, contact resistance at perovskite/ETL or perovskite/HTL interface, bulk capacitance, recombination resistance and chemical capacitance respectively.