MITSUBISHI ELECTRIC

<IGBT Modules>

CM150RX-13T/CM150RXP-13T

HIGH POWER SWITCHING USE
INSULATED TYPE

RX		Collector current I_C ..... **150** A Collector-emitter voltage V_{CES} ..... **650** V Maximum junction temperature T_{vjmax} ..... **175** °C ●Flat base type ●Copper base plate (Nickel-plating) ●RoHS Directive compliant ●Tin-plating pin terminals
RXP		Collector current I_C ..... **150** A Collector-emitter voltage V_{CES} ..... **650** V Maximum junction temperature T_{vjmax} ..... **175** °C ●Flat base type ●Copper base plate (Nickel-plating) ●RoHS Directive compliant ●Tin-plating pressfit terminals
sevenpack (three-phase bridge+Brake chopper)		●UL Recognized under UL1557, File No. E323585

APPLICATION

AC Motor Control, Motion/Servo Control, Power supply, etc.

OPTION (Below options are available.)

●PC-TIM (Phase Change Thermal Interface Material) pre-apply

INTERNAL CONNECTION

Terminal code

1 U	13 EVN
2 V	14 GVN
3 W	15 EVP
4 B	16 GVP
5 EB	17 EUN
6 GB	18 GUN
7 TH1	19 EUP
8 TH2	20 GUP
9 EWN	21 P
10 GWN	22 N
11 EWP	
12 GWP	

CM150RX-13T/CM150RXP-13T

HIGH POWER SWITCHING USE
INSULATED TYPE

OUTLINE DRAWING **Dimension in mm**

RX

Tolerance otherwise specified

Division of Dimension		Tolerance
0.5	to 3	±0.2
over 3	to 6	±0.3
over 6	to 30	±0.5
over 30	to 120	±0.8
over 120	to 400	±1.2

CM150RX-13T/CM150RXP-13T

HIGH POWER SWITCHING USE
INSULATED TYPE

OUTLINE DRAWING **Dimension in mm**

RXP

Tolerance otherwise specified

Division of Dimension		Tolerance
0.5	to 3	±0.2
over 3	to 6	±0.3
over 6	to 30	±0.5
over 30	to 120	±0.8
over 120	to 400	±1.2

MAXIMUM RATINGS (T_{vj}=25 °C, unless otherwise specified)

INVERTER PART IGBT/FWD

Symbol	Item	Conditions	Rating	Unit
V_{CES}	Collector-emitter voltage	G-E short-circuited	650	V
V_{GES}	Gate-emitter voltage	C-E short-circuited	± 20	V
I_C	Collector current	DC, T_C=106 °C (Note2, 4)	150	A
I_{CRM}		Pulse, Repetitive (Note3)	300	
P_{tot}	Total power dissipation	T_C=25 °C (Note2, 4)	560	W
I_E (Note1)	Emitter current	DC (Note2)	150	A
I_{ERM} (Note1)		Pulse, Repetitive (Note3)	300	

BRAKE PART IGBT/DIODE

Symbol	Item	Conditions	Rating	Unit
V_{CES}	Collector-emitter voltage	G-E short-circuited	650	V
V_{GES}	Gate-emitter voltage	C-E short-circuited	± 20	V
I_C	Collector current	DC, T_C=113 °C (Note2, 4)	75	A
I_{CRM}		Pulse, Repetitive (Note3)	150	
P_{tot}	Total power dissipation	T_C=25 °C (Note2, 4)	310	W
V_{RRM}	Repetitive peak reverse voltage	G-E short-circuited	650	V
I_F	Forward current	DC (Note2)	75	A
I_{FRM}		Pulse, Repetitive (Note3)	150	

MODULE

Symbol	Item	Conditions	Rating	Unit
V_{isol}	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	2500	V
T_{vjmax}	Maximum junction temperature	Instantaneous event (overload) (Note9)	175	°C
T_{Cmax}	Maximum case temperature	(Note4, 9)	125	
T_{vjop}	Operating junction temperature	Continuous operation (under switching) (Note9)	-40 ~ +150	°C
T_{stg}	Storage temperature	-	-40 ~ +125	

ELECTRICAL CHARACTERISTICS (T_{vj}=25 °C, unless otherwise specified)

INVERTER PART IGBT/FWD

Symbol	Item	Conditions		Limits			Unit
				Min.	Typ.	Max.	
I_{CES}	Collector-emitter cut-off current	V_{CE}=V_{CES}, G-E short-circuited		-	-	1.0	mA
I_{GES}	Gate-emitter leakage current	V_{GE}=V_{GES}, C-E short-circuited		-	-	0.5	μA
$V_{GE(th)}$	Gate-emitter threshold voltage	I_C=15 mA, V_{CE}=10 V		5.4	6.0	6.6	V
V_{CEsat} (Terminal)	Collector-emitter saturation voltage	I_C=150 A, V_{GE}=15 V, Refer to the figure of test circuit (Note5)	T_{vj}=25 °C	-	1.40	1.75	V
			T_{vj}=125 °C	-	1.50	-	
			T_{vj}=150 °C	-	1.55	-	
V_{CEsat} (Chip)		I_C=150 A, V_{GE}=15 V, (Note5)	T_{vj}=25 °C	-	1.30	1.55	V
			T_{vj}=125 °C	-	1.35	-	
			T_{vj}=150 °C	-	1.35	-	
C_{ies}	Input capacitance	V_{CE}=10 V, G-E short-circuited		-	-	20.1	nF
C_{oes}	Output capacitance			-	-	0.9	
C_{res}	Reverse transfer capacitance			-	-	0.4	
Q_G	Gate charge	V_{CC}=300 V, I_C=150 A, V_{GE}=15 V		-	0.62	-	μC
$t_{d(on)}$	Turn-on delay time	V_{CC}=300 V, I_C=150 A, V_{GE}=±15 V, R_G=1.0 Ω, Inductive load		-	-	400	ns
t_r	Rise time			-	-	200	
$t_{d(off)}$	Turn-off delay time			-	-	400	
t_f	Fall time			-	-	600	

ELECTRICAL CHARACTERISTICS (cont.; T_{vj}=25 °C, unless otherwise specified)

INVERTER PART IGBT/FWD

Symbol	Item	Conditions		Limits Min.	Limits Typ.	Limits Max.	Unit
V_{EC} (Note1) (Terminal)	Emitter-collector voltage	I_E=150 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T_{vj}=25 °C	-	1.50	2.05	V
			T_{vj}=125 °C	-	1.55	-	
			T_{vj}=150 °C	-	1.55	-	
V_{EC} (Note1) (Chip)		I_E=150 A, G-E short-circuited, (Note5)	T_{vj}=25 °C	-	1.45	1.85	V
			T_{vj}=125 °C	-	1.50	-	
			T_{vj}=150 °C	-	1.50	-	
t_{rr} (Note1)	Reverse recovery time	V_{CC}=300 V, I_E=150 A, V_{GE}=±15 V, R_G=1.0 Ω, Inductive load		-	-	400	ns
Q_{rr} (Note1)	Reverse recovery charge			-	12	-	μC
E_{on}	Turn-on switching energy per pulse	V_{CC}=300 V, I_C=I_E=150 A, V_{GE}=±15 V, R_G=1.0 Ω, T_{vj}=150 °C, Inductive load		-	4.3	-	mJ
E_{off}	Turn-off switching energy per pulse			-	7.2	-	
E_{rr} (Note1)	Reverse recovery energy per pulse			-	5.8	-	mJ
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, T_C=25 °C (Note4)		-	1.6	-	mΩ
r_g	Internal gate resistance	Per switch		-	4.0	-	Ω

BRAKE PART IGBT/DIODE

Symbol	Item	Conditions		Limits Min.	Limits Typ.	Limits Max.	Unit
I_{CES}	Collector-emitter cut-off current	V_{CE}=V_{CES}, G-E short-circuited		-	-	1.0	mA
I_{GES}	Gate-emitter leakage current	V_{GE}=V_{GES}, C-E short-circuited		-	-	0.5	μA
$V_{GE(th)}$	Gate-emitter threshold voltage	I_C=7.5 mA, V_{CE}=10 V		5.4	6.0	6.6	V
V_{CEsat} (Terminal)	Collector-emitter saturation voltage	I_C=75 A, V_{GE}=15 V, Refer to the figure of test circuit (Note5)	T_{vj}=25 °C	-	1.35	1.70	V
			T_{vj}=125 °C	-	1.45	-	
			T_{vj}=150 °C	-	1.50	-	
V_{CEsat} (Chip)		I_C=75 A, V_{GE}=15 V, (Note5)	T_{vj}=25 °C	-	1.30	1.55	V
			T_{vj}=125 °C	-	1.35	-	
			T_{vj}=150 °C	-	1.35	-	
C_{ies}	Input capacitance	V_{CE}=10 V, G-E short-circuited		-	-	10.1	nF
C_{oes}	Output capacitance			-	-	0.5	
C_{res}	Reverse transfer capacitance			-	-	0.2	
Q_G	Gate charge	V_{CC}=300 V, I_C=75 A, V_{GE}=15 V		-	0.31	-	μC
$t_{d(on)}$	Turn-on delay time	V_{CC}=300 V, I_C=75 A, V_{GE}=±15 V, R_G=8.2 Ω, Inductive load		-	-	400	ns
t_r	Rise time			-	-	200	
$t_{d(off)}$	Turn-off delay time			-	-	400	
t_f	Fall time			-	-	600	
E_{on}	Turn-on switching energy per pulse	V_{CC}=300 V, I_C=75 A, V_{GE}=±15 V, R_G=8.2 Ω, T_{vj}=150 °C, Inductive load		-	1.37	-	mJ
E_{off}	Turn-off switching energy per pulse			-	3.63	-	
r_g	Internal gate resistance	-		-	0	-	Ω
I_{RRM}	Reverse current	V_R=V_{RRM}, G-E short-circuited		-	-	1.0	mA
V_F (Terminal)	Forward voltage	I_F=75 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T_{vj}=25 °C	-	1.60	2.15	V
			T_{vj}=125 °C	-	1.65	-	
			T_{vj}=150 °C	-	1.65	-	
V_F (Chip)		I_F=75 A, G-E short-circuited, (Note5)	T_{vj}=25 °C	-	1.45	1.85	V
			T_{vj}=125 °C	-	1.50	-	
			T_{vj}=150 °C	-	1.50	-	
t_{rr}	Reverse recovery time	V_{CC}=300 V, I_F=75 A, V_{GE}=±15 V, R_G=8.2 Ω, Inductive load		-	-	400	ns
Q_{rr}	Reverse recovery charge			-	3.4	-	μC
E_{rr}	Reverse recovery energy per pulse	V_{CC}=300 V, I_F=75 A, V_{GE}=±15 V, R_G=8.2 Ω, T_{vj}=150 °C, Inductive load		-	2.76	-	mJ

ELECTRICAL CHARACTERISTICS (cont.; T_{vj}=25 °C, unless otherwise specified)

NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R_{25}	Zero-power resistance	T_C=25 °C (Note4)	4.85	5.00	5.15	kΩ
ΔR/R	Deviation of resistance	R_{100}=493 Ω, T_C=100 °C (Note4)	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation (Note6)	-	3375	-	K
P_{25}	Power dissipation	T_C=25 °C (Note4)	-	-	10	mW

THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance	Junction to case, per Inverter IGBT (Note4)	-	-	267	K/kW
$R_{th(j-c)D}$		Junction to case, per Inverter FWD (Note4)	-	-	393	
$R_{th(j-c)Q}$	Thermal resistance	Junction to case, Brake IGBT (Note4)	-	-	479	K/kW
$R_{th(j-c)D}$		Junction to case, Brake DIODE (Note4)	-	-	708	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, Thermal grease applied (Note4, 7, 9)	-	11.5	-	K/kW

MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
M_t	Mounting torque	Main terminals M 6 screw	3.5	4.0	4.5	N·m
M_s	Mounting torque	Mounting to heat sink M 5 screw	2.5	3.0	3.5	N·m
d_s	Creepage distance	Terminal to terminal	17	-	-	mm
		Terminal to base plate	18.4	-	-	
d_a	Clearance	Terminal to terminal	10	-	-	mm
		Terminal to base plate	16.2	-	-	
e_c	Flatness of base plate	On the centerline X, Y (Note8)	±0	-	+200	μm
m	mass	-	-	330	-	g

*: This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU and (EU) 2015/863.

Note1. Represent ratings and characteristics of the anti-parallel, emitter-collector free-wheeling diode (FWD).

2. Junction temperature (T_{vj}) should not increase beyond T_{vjmax} rating.

3. Pulse width and repetition rate should be such that the device junction temperature (T_{vj}) dose not exceed T_{vjmax} rating.

4. Case temperature (T_C) and heat sink temperature (T_S) are defined on the each surface (mounting side) of base plate and heat sink just under the chips. Refer to the figure of chip location.

5. Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.

6. $B_{(25/50)} = \ln(\frac{R_{25}}{R_{50}}) / (\frac{1}{T_{25}} - \frac{1}{T_{50}})$

R_{25}: resistance at absolute temperature T_{25} [K]; T_{25}=25 [°C]+273.15=298.15 [K]

R_{50}: resistance at absolute temperature T_{50} [K]; T_{50}=50 [°C]+273.15=323.15 [K]

7. Reference value. Thermally conductive grease of thermal conductivity λ=0.9 W/(m·K) and thickness $D_{(C-S)}$=50 μm.

8. The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.

9. Long term performance related to thermal conductive grease (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under user's specific application conditions. Each temperature condition ($T_{vj\,max}$, $T_{vj\,op}$, $T_{C\,max}$) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

Note10. Use the following screws when mounting the printed circuit board (PCB) on the standoffs.
PCB thickness : t=1.6.

	Type	Size	Tightening torque	Recommended tightening method
(1)	PT®	K25×8	0.55 ± 0.055 N･m	by handwork (equivalent to 30 rpm by mechanical screw driver) ~ 600 rpm (by mechanical screw driver)
(2)	PT®	K25×10	0.75 ± 0.075 N･m	
(3)	DELTA PT®	25×8	0.55 ± 0.055 N･m	
(4)	DELTA PT®	25×10	0.75 ± 0.075 N･m	
(5)	B1 tapping screw	φ2.6×10 or φ2.6×12	0.75 ± 0.075 N･m	

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{CC}	(DC) Supply voltage	Applied across P-N terminals	-	300	450	V
V_{GEon}	Gate (-emitter drive) voltage	Applied across G*P-E*P/G*N-E*N/GB-EB terminals (*=U,V,W)	13.5	15.0	16.5	V
R_G	External gate resistance	Inverter IGBT, Per switch	1.0	-	39	Ω
		Brake IGBT	8.2	-	82	

CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm

RX

RXP

Tr*P/Tr*N/TrBr: IGBT, Di*P/Di*N: FWD, DiBr: DIODE, Th: NTC thermistor

TEST CIRCUIT AND WAVEFORMS

Switching characteristics test circuit and waveforms

t_{rr}, Q_{rr} characteristics test waveform

IGBT Turn-on switching energy

IGBT Turn-off switching energy

FWD Reverse recovery energy

Switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

TEST CIRCUIT

TrUP

TrVP

TrWP

TrUN

Gate-emitter short-circuited GVP-EVP, GVN-EVN, GWP-EWP, GWN-EWN GB-EB

TrVN

Gate-emitter short-circuited GUP-EUP, GUN-EUN, GWP-EWP, GWN-EWN GB-EB

TrWN

Gate-emitter short-circuited GUP-EUP, GUN-EUN, GVP-EVP, GVN-EVN GB-EB

Gate-emitter short-circuited GUP-EUP, GUN-EUN, GVP-EVP, GVN-EVN, GWP-EWP, GWN-EWN

V_{CEsat} characteristics test circuit

DiUP

DiVP

DiWP

DiUN

Gate-emitter short-circuited GVP-EVP, GVN-EVN, GWP-EWP, GWN-EWN GB-EB

DiVN

Gate-emitter short-circuited GUP-EUP, GUN-EUN, GWP-EWP, GWN-EWN GB-EB

DiWN

Gate-emitter short-circuited GUP-EUP, GUN-EUN, GVP-EVP, GVN-EVN GB-EB

V_{EC} characteristics test circuit

Gate-emitter short-circuited GUP-EUP, GUN-EUN, GVP-EVP, GVN-EVN, GWP-EWP, GWN-EWN

V_F characteristics test circuit

PERFORMANCE CURVES

INVERTER PART

OUTPUT CHARACTERISTICS (TYPICAL)

COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)

COLLECTOR-EMITTER VOLTAGE CHARACTERISTICS (TYPICAL)

FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)

PERFORMANCE CURVES

INVERTER PART

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, R_G=1.0 Ω, V_{GE}=±15 V, INDUCTIVE LOAD
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, I_C=150 A, V_{GE}=±15 V, INDUCTIVE LOAD
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, R_G=1.0 Ω, V_{GE}=±15 V, INDUCTIVE LOAD,
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C, PER PULSE

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, I_C/I_E=150 A, V_{GE}=±15 V, INDUCTIVE LOAD,
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C, PER PULSE

PERFORMANCE CURVES

INVERTER PART

CAPACITANCE CHARACTERISTICS (TYPICAL)

G-E short-circuited, T_{vj}=25 °C

FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, R_G=1.0 Ω, V_{GE}=±15 V, INDUCTIVE LOAD
———: T_j=150 °C, - - - - -: T_j=125 °C

GATE CHARGE CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, I_C=150 A, T_{vj}=25 °C

TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, T_C=25 °C
$R_{th(j-c)Q}$=267 K/kW, $R_{th(j-c)D}$=393 K/kW

i	1	2	3	4
Ri [K/kW]	0.0124	0.0739	0.3505	0.5632
τi [s]	1.961E-05	0.0014	0.0179	0.0944

PERFORMANCE CURVES

INVERTER PART

TURN-OFF SWITCHING SAFE OPERATIONG AREA (REVERSE BIAS SAFE OPERATING AREA) (MAXIMUM)

V_{CC}≤450 V, R_G=1.0~39 Ω, V_{GE}=±15 V,
————: T_{vj}=25~150 °C (Normal load operations (Continuous)
- - - - - -: T_{vj}=175 °C (Unusual load operations (Limited period)

SHORT-CIRCUIT SAFE OPERATING AREA (MAXIMUM)

V_{CC}≤400 V, R_G=1.0~39 Ω, V_{GE}=±15 V,
T_{vj}= 25 ~ 150 °C, t_W≤8 μs, Non-Repetitive

PERFORMANCE CURVES

BRAKE PART

OUTPUT CHARACTERISTICS (TYPICAL)

COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)

COLLECTOR-EMITTER VOLTAGE CHARACTERISTICS (TYPICAL)

DIODE FORWARD CHARACTERISTICS (TYPICAL)

PERFORMANCE CURVES

BRAKE PART

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, R_G=8.2 Ω, V_{GE}=±15 V, INDUCTIVE LOAD
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, I_C=75 A, V_{GE}=±15 V, INDUCTIVE LOAD
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, R_G=8.2 Ω, V_{GE}=±15 V, INDUCTIVE LOAD,
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C, PER PULSE

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, I_C/I_E=75 A, V_{GE}=±15 V, INDUCTIVE LOAD,
———: T_{vj}=150 °C, - - - - -: T_{vj}=125 °C, PER PULSE

PERFORMANCE CURVES

BRAKE PART

CAPACITANCE CHARACTERISTICS (TYPICAL)

G-E short-circuited, T_{vj}=25 °C

DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, R_G=8.2 Ω, V_{GE}=±15 V, INDUCTIVE LOAD
———: T_j=150 °C, - - - - -: T_j=125 °C

GATE CHARGE CHARACTERISTICS (TYPICAL)

V_{CC}=300 V, I_C=75 A, T_{vj}=25 °C

TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, T_C=25 °C
$R_{th(j-c)Q}$=479 K/kW, $R_{th(j-c)D}$=708 K/kW

i	1	2	3	4
Ri [K/kW]	0.0124	0.0739	0.3505	0.5632
τi [s]	1.961E-05	0.0014	0.0179	0.0944

PERFORMANCE CURVES

BRAKE PART

TURN-OFF SWITCHING SAFE OPERATIONG AREA (REVERSE BIAS SAFE OPERATING AREA) (MAXIMUM)

V_{CC}≤450 V, R_G=8.2~82 Ω, V_{GE}=±15 V,
————: T_{vj}=25~150 °C (Normal load operations (Continuous)
- - - - - -: T_{vj}=175 °C (Unusual load operations (Limited period)

SHORT-CIRCUIT SAFE OPERATING AREA (MAXIMUM)

V_{CC}≤400 V, R_G=8.2~82 Ω, V_{GE}=±15 V,
T_{vj}= 25 ~ 150 °C, t_W≤8 μs, Non-Repetitive

NTC thermistor part

TEMPERATURE CHARACTERISTICS (TYPICAL)

Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Important Notice

The information contained in this datasheet shall in no event be regarded as a guarantee of conditions or characteristics. This product has to be used within its specified maximum ratings, and is subject to customer's compliance with any applicable legal requirement, norms and standards.

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