

LM2941QML 1A Low Dropout Adjustable Regulator

Check for Samples: LM2941QML, LM2941QML-SP

FEATURES

- Available with Radiation Ensure
 - ELDRS Free 100 krad(Si)
- Output Voltage Adjustable from 5V to 20V
- Dropout Voltage Typically 0.5V at $I_0 = 1A$
- **Output Current in Excess of 1A**
- **Trimmed Reference Voltage**
- **Reverse Battery Protection**
- Internal Short Circuit Current Limit
- **Mirror Image Insertion Protection**
- TTL, CMOS Compatible ON/OFF Switch

DESCRIPTION

The LM2941 positive voltage regulator features the ability to source 1A of output current with a typical dropout voltage of 0.5V and a maximum of 1V over the entire temperature range. Furthermore, a quiescent current reduction circuit has been included which reduces the ground pin current when the differential between the input voltage and the output voltage exceeds approximately 3V. The quiescent current with 1A of output current and an input-output differential of 5V is therefore only 30mA. Higher quiescent currents only exist when the regulator is in the dropout mode $(V_1 - V_0 \le 3V)$.

Originally designed for vehicular applications, the LM2941 and all regulated circuitry are protected from reverse battery installations or two-battery jumps. During line transients, such as load dump when the input voltage can momentarily exceed the specified maximum operating voltage, the regulator will automatically shut down to protect both the internal circuits and the load. Familiar regulator features such as short circuit and thermal overload protection are also provided.

Connection Diagram

Top View

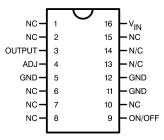
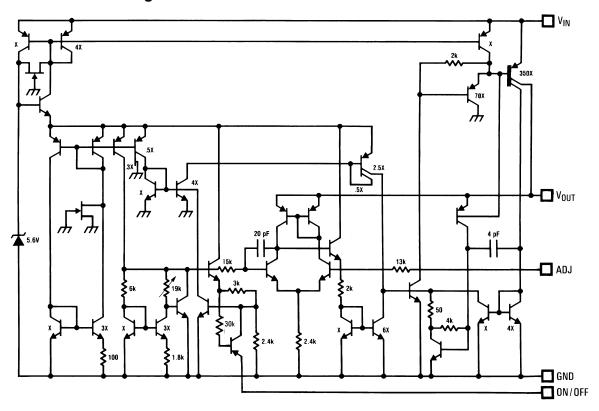


Figure 1. 16-Lead CFP Package

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Equivalent Schematic Diagram





These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.



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Absolute Maximum Ratings⁽¹⁾

Input Voltage (Survival Voltage, ≤ 10	Maximum Junction Temperature Storage Temperature Range					
Internal Power Dissipation (2)			Internally Limited			
Maximum Junction Temperature			150°C			
Storage Temperature Range			-65°C ≤ T _J ≤ +150°C			
Lead Temperature (Soldering, 10 sec	conds)		300°C			
		CFP "WG" (device 01, 02) (Still Air)	122°C/W			
	0	CFP "WG" (device 01, 02) (500LF/Min Air Flow)	77°C/W			
Thermal Decistores	θ_{JA}	CFP "GW" (device 03, 04) (Still Air)	136°C/W			
Thermal Resistance		CFP "GW" (device 03, 04) (500LF/Min Air Flow)	87°C/W			
	0	CFP "WG" (device 01, 02) ⁽³⁾	5°C/W			
	$\theta_{ m JC}$	CFP "GW" (device 03, 04)	13°C/W			
Dooks as Weight (Typ)		CFP "WG" (device 01, 02)	360mg			
Package Weight (Typ)		CFP "GW" (device 03, 04)	410mg			
ESD susceptibility to be determined (4	1)		500V			

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For specified specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (2) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (package junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $P_{Dmax} = (T_{Jmax} T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower.
- (3) The package material for these devices allows much improved heat transfer over our standard ceramic packages. In order to take full advantage of this improved heat transfer, heat sinking must be provided between the package base (directly beneath the die), and either metal traces on, or thermal vias through, the printed circuit board. Without this additional heat sinking, device power dissipation must be calculated using θ_{JA}, rather than θ_{JC}, thermal resistance. It must not be assumed that the device leads will provide substantial heat transfer out of the package, since the thermal resistance of the lead frame material is very poor, relative to the material of the package base. The stated θ_{JC} thermal resistance is for the package material only, and does not account for the additional thermal resistance between the package base and the printed circuit board. The user must determine the value of the additional thermal resistance and must combine this with the stated value for the package, to calculate the total allowed power dissipation for the device.
- (4) Human body model, 1.5 k Ω in series with 100 pF.

Recommended Operating Conditions

Maximum Input Voltage	26V
Temperature Range	-55°C ≤ T _A ≤ 125°C

Product Folder Links: LM2941QML LM2941QML-SP

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Table 1. Quality Conformance Inspection Mil-Std-883, Method 5005 - Group A

Subgroup	Description	Temp °C
1	Static tests at	+25
2	Static tests at	+125
3	Static tests at	-55
4	Dynamic tests at	+25
5	Dynamic tests at	+125
6	Dynamic tests at	-55
7	Functional tests at	+25
8A	Functional tests at	+125
8B	Functional tests at	-55
9	Switching tests at	+25
10	Switching tests at	+125
11	Switching tests at	-55
12	Settling time at	+25
13	Settling time at	+125
14	Settling time at	-55

LM2941 Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified.

DC: $5V \le V_O \le 20V$, $V_{IN} = V_O + 5V$, $C_O = 22\mu F$

Parameter		Test Conditions	Notes	Min	Max	Unit	Sub- groups	
V _{Ref}	Poforonoo Voltago	5m\ < 1 < 1\		1.237	1.313	V	1	
	Reference Voltage	5mA ≤ I _O ≤ 1A		1.211	1.339	V	2, 3	
V _{RLine}	Line Regulation	$V_{O} + 2V \le V_{IN} \le 26V, I_{O} = 5mA$	See ⁽¹⁾		10	mV/V	1, 2, 3	
M	Load Regulation	$50\text{mA} \le I_{O} \le 1\text{A}, \ V_{IN} = 10\text{V}, \ V_{OUT} = 5\text{V}$	See ⁽¹⁾		10	mV/V	1, 2, 3	
V_{RLoad}	Load Regulation	$50\text{mA} \le I_{O} \le 1\text{A}, \ V_{IN} = 25\text{V}, \ V_{OUT} = 20\text{V}$	See		10	mV/V	1, 2, 3	
		\\ \ \ 2\\\ < \\ \ < 26\\ \ \ - 5m\			15	mA	1	
IQ	Outroport Comment	$V_{O} + 2V \le V_{IN} \le 26V, I_{O} = 5mA$			20	mA	2, 3	
	Quiescent Current	$V_{IN} = V_O + 5V, I_O = 1A$			45	mA	1	
		$V_{IN} = V_{O} + 5V, I_{O} = IA$			60	mA	2, 3	
		I _O = 1A			0.8	V	1	
V	Dropout Voltage	10 = 114			1.0	V	2, 3	
V_{DO}		I _O = 100mA			200	mV	1	
		10 = 100111A			300	mV	2, 3	
	Short Circuit Current	V - 26V		1.6	3.5	Α	1	
I _{SC}	Short Circuit Current	$V_{IN\ Max} = 26V$		1.3	3.7	Α	2, 3	
	Maximum Operational Input Voltage		See ⁽²⁾		26	V_{DC}	1, 2, 3	
	Reverse Polarity DC Input Voltage	$R_O = 100\Omega$, $V_O \ge -0.6V$	See ⁽³⁾	-15		V	1, 2, 3	
V _{TH On}	ON/OFF Threshold Voltage ON	I _O ≤ 1A	See ⁽³⁾		0.8	V	1, 2, 3	
V _{Th Off}	ON/OFF Threshold Voltage OFF	I _O ≤ 1A	See ⁽³⁾	2.00		V	1, 2, 3	
	ON/OFF Threshold Current	V _{ON/OFF} = 2.0V, I _O ≤ 1A			100	μΑ	1	
	ON/OFF THESHOLD CUITERS	VON/OFF = 2.0V, IO ≥ IA			300	μΑ	2, 3	

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⁽¹⁾ Limit = mV per volt of V_O.
(2) Condition for V_{IN}
(3) Functional test go-no-go only.



LM2941 Electrical Characteristics AC Parameters

The following conditions apply, unless otherwise specified.

AC: $5V \le V_O \le 20V$, $V_{IN} = V_O + 5V$, $C_O = 22\mu F$

	Parameter	Test Conditions	Notes	Min	Max	Unit	Sub- groups
	Maximum Line Transient	$V_{O~Max}$ 1V above nominal V_{O} , R_{O} = 100 Ω , t ≤ 100mS		60		V	4, 5, 6
	Reverse Polarity Transient Input Voltage	$t \le 100 \text{mS}, R_0 = 100 \Omega$		-50		V	4, 5, 6
RR	Dinale Dejection	$f_{\rm O}$ = 1KHz, 1 V _{RMS} , I _L = 100mA	See ⁽¹⁾		0.02	%/V	4
KK	Ripple Rejection	$f_{\rm O}$ = 1KHz, 1 V _{RMS} , I _L = 100mA	See ⁽¹⁾		0.04	%/V	5, 6

⁽¹⁾ %/V = % of V_{IN} per Volt of V_O .

LM2941 Electrical Characteristics DC Drift Parameters

The following conditions apply, unless otherwise specified.

DC: $5V \le V_O \le 20V$, $V_{IN} = V_O + 5V$, $C_O = 22\mu F$

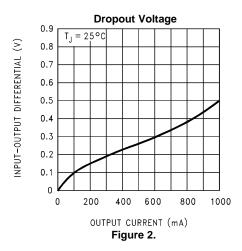
Delta calculations performed on QMLV devices at group B, subgroup 5.

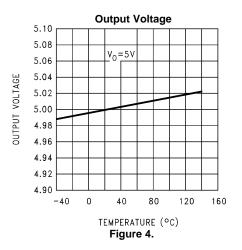
	Parameter	Test Conditions	Notes	Min	Max	Unit	Sub- groups
V_{Ref}	Reference Voltage	5mA ≤ I _O ≤ 1A		-25	+25	mV	1

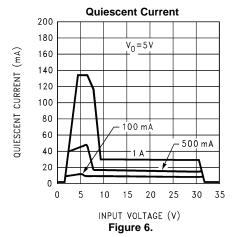
Product Folder Links: LM2941QML LM2941QML-SP

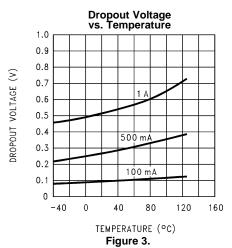


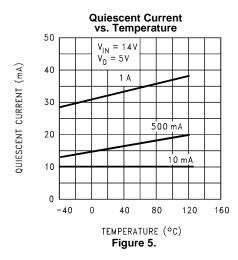
Typical Performance Characteristics

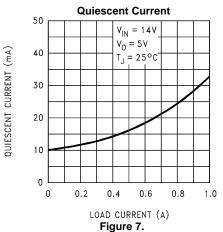






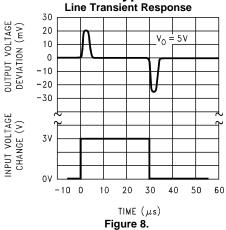


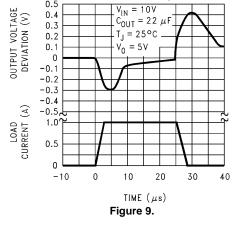




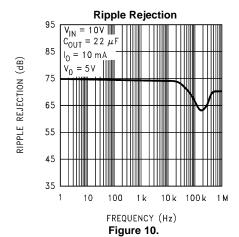


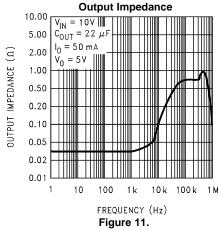
Typical Performance Characteristics (continued)

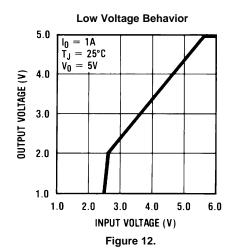


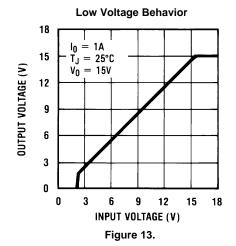


Load Transient Response











Typical Performance Characteristics (continued) Output Capacitor ESR Output at Vo

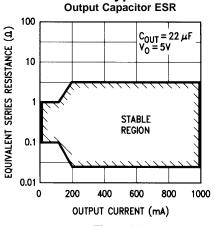
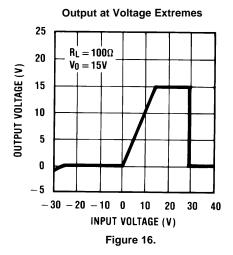


Figure 14.



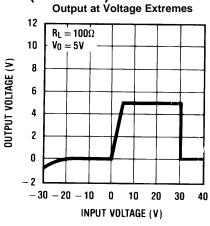
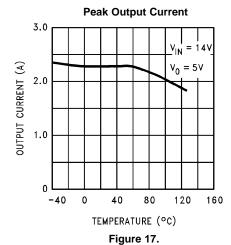
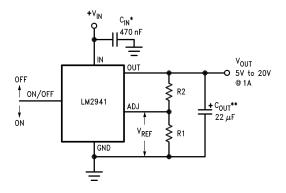


Figure 15.





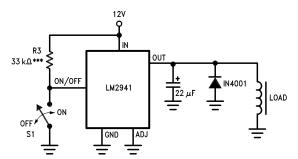
Typical Applications



$$\begin{split} &V_{OUT} = \text{Reference voltage} \times \frac{\text{R1} + \text{R2}}{\text{R1}} \text{ where } V_{REF} = 1.275 \text{ typical} \end{split}$$
 Solving for R2: R2 = R1 $\left(\frac{V_O}{V_{REF}} - 1\right)$

Note: Using $1K\Omega$ for R1 will ensure that the input bias current error of the adjust pin will be negligible. Do not bypass R1 or R2. This will lead to instabilities.

Figure 18. 5V to 20V Adjustable Regulator



*** To assure shutdown, select Resistor R3 to ensure at least 300µA of pull-up current when S1 is open. (Assume 2V at the ON/OFF pin.)

Figure 19. 1A Switch

^{*} Required if regulator is located far from power supply filter.

^{**} C_O must be at least 22µF to maintain stability. May be increased without bound to maintain regulation during transients. Locate as close as possible to the regulator. This capacitor must be rated over the same operating temperature range as the regulator and the ESR is critical; see curve.



REVISION HISTORY SECTION

Released	Revision	Section	Changes
08/25/09	А	New Release, Corporate format	1 MDS data sheet converted into one Corp. data sheet format. Added Radiation products to ordering table. MNLM2941-X Rev 4A1 will be archived.
12-Oct-2011	В	Ordering Information, Absolute Max Ratings	Ordering Information — Added LM2941GW/883, LM2941GW-QMLV and LM2941GWRLQMLV. Absolute Max — Added Theta JA and Theta JC along with Package weight of 'GW' devices. RatingsLM2941QML Rev A will be archived.

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NSTRUMENTS

SNVS390B -AUGUST 2009-REVISED APRIL 2013

REVISION HISTORY

Cł	hanges from Revision A (April 2013) to Revision B	Page
•	Changed layout of National Data Sheet to TI format	9

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11-Nov-2025

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
5962-9166703QYA	Active	Production	CFP (NAC) 16	88 TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM2941GW /883 Q 5962-91667 03QYA ACO 03QYA >T
5962-9166703VYA	Active	Production	CFP (NAC) 16	88 JEDEC TRAY (5+1)	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM2941GW- QMLV Q 5962-91667 03VYA ACO 03VYA >T
5962R9166702V9A	Active	Production	DIESALE (Y) 0	34 NOT REQUIRED	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	
5962R9166704VYA	Active	Production	CFP (NAC) 16	88 JEDEC TRAY (5+1)	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM2941GWRL QMLV Q 5962R91667 04VYA ACO 04VYA >T
LM2941 MDE	Active	Production	DIESALE (Y) 0	34 NOT REQUIRED	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	
LM2941-MD8	Active	Production	DIESALE (Y) 0	221 NOT REQUIRED	Yes	Call TI	Level-1-NA-UNLIM	-	
LM2941GW-QMLV	Active	Production	CFP (NAC) 16	88 JEDEC TRAY (5+1)	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM2941GW- QMLV Q 5962-91667 03VYA ACO 03VYA >T
LM2941GW/883	Active	Production	CFP (NAC) 16	88 TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM2941GW /883 Q 5962-91667 03QYA ACO 03QYA >T
LM2941GWRLQMLV	Active	Production	CFP (NAC) 16	88 JEDEC TRAY (5+1)	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM2941GWRL QMLV Q 5962R91667 04VYA ACO 04VYA >T

⁽¹⁾ Status: For more details on status, see our product life cycle.

PACKAGE OPTION ADDENDUM

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(2) Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) MSL rating/Peak reflow: The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF LM2941QML, LM2941QML-SP:

Military: LM2941QML

Space: LM2941QML-SP

NOTE: Qualified Version Definitions:

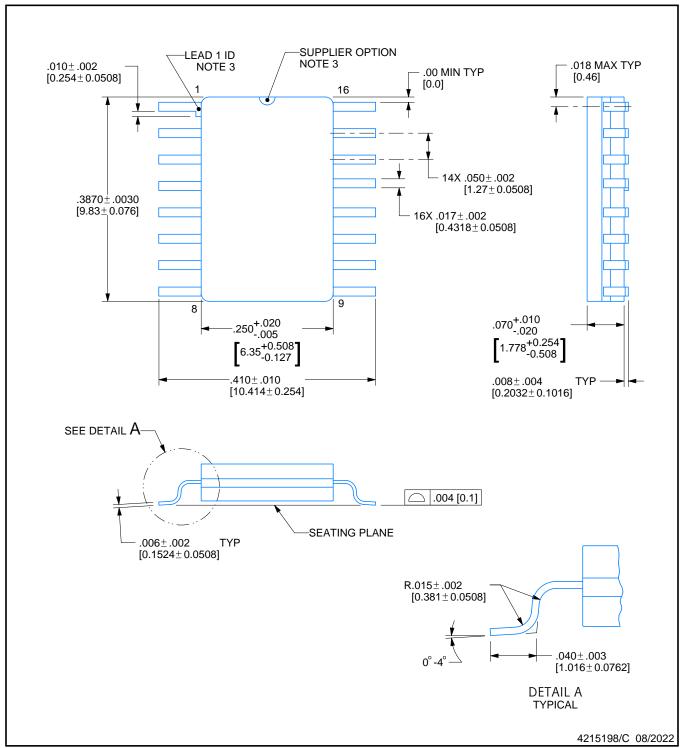
• Military - QML certified for Military and Defense Applications

• Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

Addendum-Page 2



CERAMIC FLATPACK

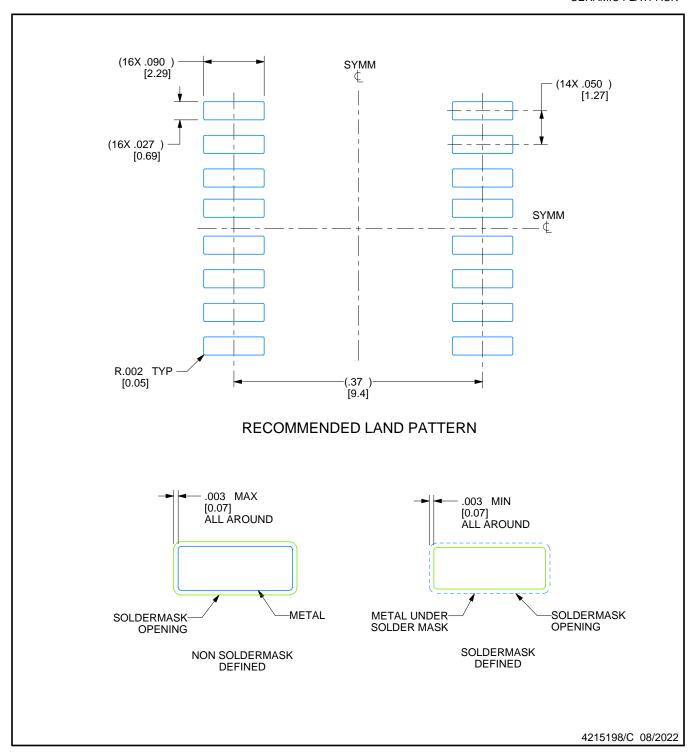


NOTES:

- 1. Controlling dimension is Inch. Values in [] are milimeters. Dimensions in () for reference only.
 2. For solder thickness and composition, see the "Lead Finish Composition/Thickness" link in the packaging section of the Texas Instruments website
- 3. Lead 1 identification shall be:
 - a) A notch or other mark within this area
 - b) A tab on lead 1, either side
- 4. No JEDEC registration as of December 2021



CERAMIC FLATPACK



		RF\/IS	SIONS				
REV	DESCRIPTION	vic	2.3.10	E.C.N.	DATE	BY/AP	P'D
A B C	RELEASE TO DOCUMENT CONTROL NO CHANGE TO DRAWING; REVISION FOR YODA RELEASE; .387± .003 WAS .39000± .00012;			2197879 2198832 2200917	12/30/2021 02/15/2022 08/08/2022	TINA TRAN / A K. SINCE D. CHIN / K. S	ANIS FAUZI RBOX
		SCALE	SIZE A		421519	98	REV PAGE 4 OF 4

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