

# Single-Stage Flyback or Buck-Boost Current Control with Active PFC and Integrated High Voltage MOSFET

## DESCRIPTION

TS19706CS is a very efficient constant current controller IC for low cost non-dimmable LED lighting applications. The TS19706CS is configurable for either isolated primary side Flyback regulation or non-isolated buck-boost current regulation topology. Integrated 630V Power MOSFET and active power factor correction in Flyback mode reduces the external components required and BOM for implementation. The IC achieves high power factor correction and low total harmonic distortion (THD) with Boundary Conduction Mode (BCM) operation. Temperature compensation of line/load regulation allows constant current accuracy to be maintained to  $\pm 3\%$ . TS19706CS also provides over temperature protection,  $V_{CC}$  overvoltage protection, and system output open and short circuit protection.

## FEATURES

- Integrated 630V MOSFET
- Constant Current Accuracy within  $\pm 3\%$
- Primary-Side Feedback Control
- Application Voltage Range  $80 V_{AC} \sim 308 V_{AC}$
- Transition-Mode PFC Operation
- Built-in Active Power Factor Correction
- Good Line and Load Regulation
- Open-LED Protection on DMG pin
- Over-Voltage Protection on  $V_{CC}$  pin
- Short-LED Protection
- Cycle-by-Cycle Over Current Protection on CS pin
- Over-Temperature Protection
- Compliant to RoHS Directive 2011/65/EU and WEEE 2002/96/EC.
- Halogen-free according to IEC 61249-2-21.

## APPLICATION

- LED lighting
- Down lights, Tube lamps, PAR Lamps, Bulbs

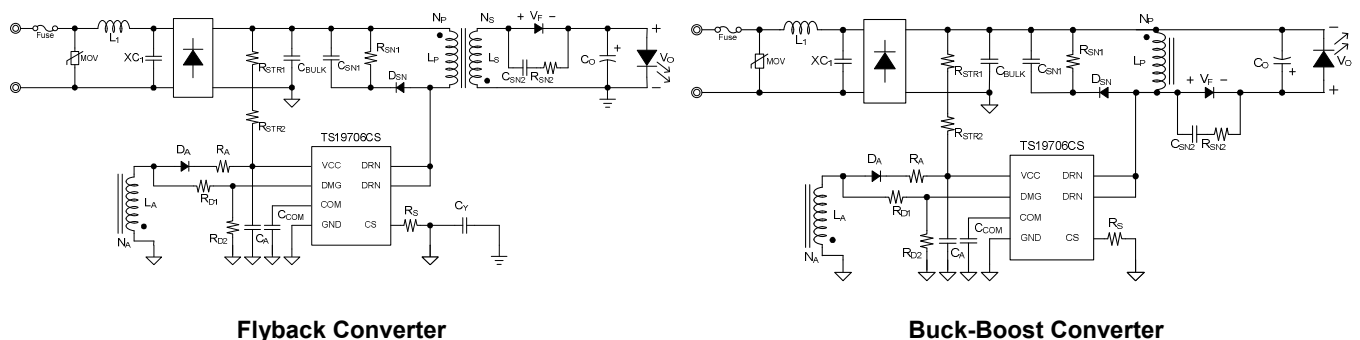


### Pin Definition:

- |             |        |
|-------------|--------|
| 1. GND      | 8. CS  |
| 2. COM      | 7. NC  |
| 3. DMG      | 6. DRN |
| 4. $V_{CC}$ | 5. DRN |

**Notes:** MSL 3 (Moisture Sensitivity Level) per J-STD-020

## TYPICAL APPLICATION CIRCUIT



<b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise specified) <sup>(Note 1)</sup>			
PARAMETER	SYMBOL	LIMIT	UNIT
DRN Pin Voltage to GND	$V_{\text{DRN}}$	630	V
Power supply pin	$V_{\text{CC}}$	40	V
DMG voltage to GND	$V_{\text{DMG}}$	-0.3 to 40	V
CS voltage to GND	$V_{\text{CS}}$	-0.3 to 5.5	V
COM voltage to GND	$V_{\text{COM}}$	-0.3 to 5.5	V
Junction Temperature Range	$T_J$	-40 to +150	$^\circ\text{C}$
Storage Temperature Range	$T_{\text{STG}}$	-65 to +150	$^\circ\text{C}$
Power Dissipation @ $T_A=50^\circ\text{C}$	$P_D$	0.4	W
ESD Rating (Human Body Model) <sup>(Note 2)</sup>	ESD	2	kV

<b>THERMAL PERFORMANCE</b> <sup>(Note 3)</sup>			
PARAMETER	SYMBOL	LIMIT	UNIT
Thermal Resistance - Junction to Case	$R_{\theta\text{JC}}$	50	$^\circ\text{C/W}$
Thermal Resistance - Junction to Ambient	$R_{\theta\text{JA}}$	208	$^\circ\text{C/W}$

<b>RECOMMENDED OPERATING CONDITION</b> ( $T_A = 25^\circ\text{C}$ unless otherwise specified) <sup>(Note 4)</sup>			
PARAMETER	SYMBOL	LIMIT	UNIT
DRN Pin Voltage to GND	$V_{\text{DRN}}$	600	V
Power supply pin	$V_{\text{CC}}$	33	V
DMG voltage to GND	$V_{\text{DMG}}$	-0.3 to 10	V
CS voltage to GND	$V_{\text{CS}}$	-0.3 to 5	V
COM voltage to GND	$V_{\text{COM}}$	-0.3 to 5	V
Operating Junction Temperature Range	$T_J$	-40 to +125	$^\circ\text{C}$
Operating Ambient Temperature Range	$T_{\text{OPA}}$	-40 to +85	$^\circ\text{C}$

<b>ELECTRICAL SPECIFICATIONS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
<b>Supply Voltage</b>						
Turn-on Voltage	$V_{\text{CC\_ON}}$		14.3	15.3	16.3	V
Turn-off Voltage	$V_{\text{CC\_OFF}}$		7.3	7.8	8.3	V
Quiescent Current 1	$I_{\text{Q1}}$	$V_{\text{CC}}=12\text{V}$ , @ $V_{\text{CC}}$ off	--	25	37.5	$\mu\text{A}$
Quiescent Current 2	$I_{\text{Q2}}$	Start-up @ 4.5kHz	--	550	825	$\mu\text{A}$
Operation Supply Current	$I_{\text{CC}}$		--	1.5	2.5	mA
<b>Protection</b>						
VCC voltage protection	$V_{\text{OVPA}}$		32.3	34	35.7	V
Output voltage protection	$V_{\text{OVPS}}$		9.5	10	10.5	V
CS limit voltage	$V_{\text{OCP}}$		1.2	1.35	1.5	V
CS limit voltage (start-up)	$V_{\text{OCP\_STR}}$		--	0.43	--	V
Short circuit protection <sup>(Note 5)</sup>	$V_{\text{SCP}}$		--	3.0	--	V

<b>ELECTRICAL SPECIFICATIONS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
<b>Oscillator</b>						
Start-up Timer	$t_{STR}$		--	222	--	$\mu\text{s}$
<b>GM Amplifier</b>						
Reference voltage	$V_{REF}$		362.6	370	377.4	mV
Transconductance	$G_m$		--	60	--	$\mu\text{A/V}$
Sink Current	$I_{COMP\_SINK}$		--	20	--	$\mu\text{A}$
Source Current	$I_{COMP\_SOU}$		--	20	--	$\mu\text{A}$
<b>Driver</b>						
Dropout voltage	$V_{OH}$	$I_o = 10\text{mA}$	--	0.7	--	V
	$V_{OL}$	$I_o = -10\text{mA}$	--	0.2	--	V
Rising time	$t_r$	$V_{CC}=20\text{V}, C_o = 1\text{nF}$	--	60	--	ns
Falling time	$t_f$	$V_{CC}=20\text{V}, C_o = 1\text{nF}$	--	80	--	ns
Output clamp voltage	$V_{O\_CLAMP}$		--	13	15.0	V
Leading edge blanking time <sup>(Note 5)</sup>	$LEB_t$		--	0.5	--	$\mu\text{s}$
<b>MOSFET Section</b>						
Drain-Source Breakdown Voltage	$BV_{DS}$		630	--	--	V
Drain-Source On-Resistance	$R_{DS(ON)}$	$V_{GS}=10\text{V}, I_D=1\text{A}$	--	3.2	3.8	$\Omega$
<b>Thermal Section</b> <sup>(Note 5, 6)</sup>						
Thermal Shutdown			--	130	--	$^\circ\text{C}$

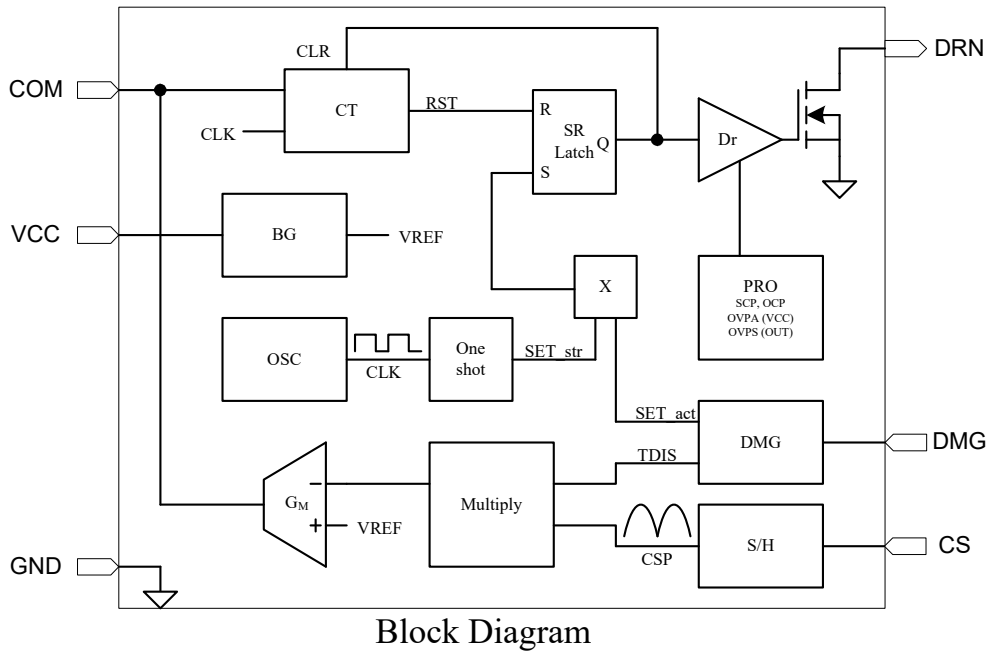
**Note:**

- Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.
- Devices are ESD sensitive. Handling precautions recommended.
- Thermal Resistance is specified with the component mounted on a low thermal conductivity test board in free air at  $T_A=25^\circ\text{C}$ .
- The device is not guaranteed to function outside its operating conditions.
- Guaranteed by design.
- Linear degeneration Type.

**ORDERING INFORMATION**

PART NO.	PACKAGE	PACKING
TS19706CS RLG	SOP-8	2,500pcs / 13"Reel

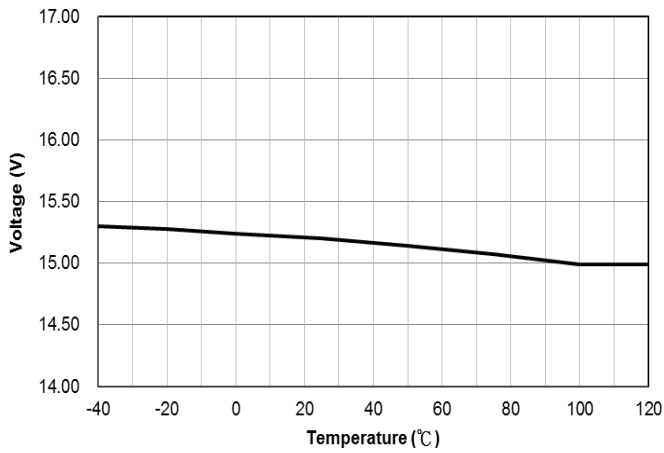
**FUNCTION BLOCK**



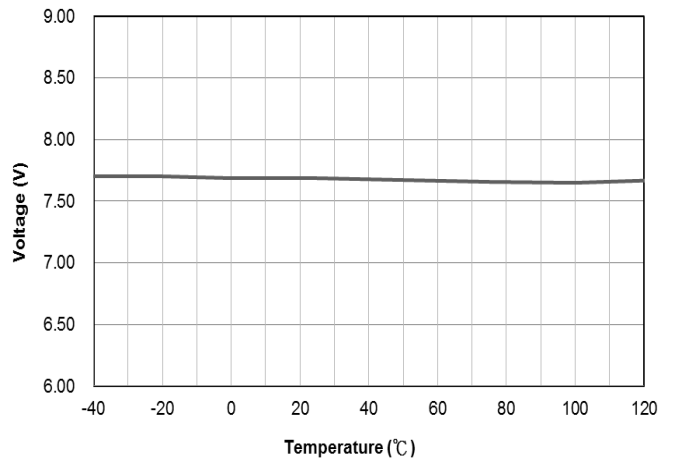
**PIN DESCRIPTION**

PIN NO.	NAME	FUNCTION
1	GND	Ground return for all internal circuitry.
2	COM	Output pin of error amplifier.
3	DMG	Zero current demagnetization sensing.
4	V <sub>CC</sub>	Power supply pin for all internal circuitry.
5	DRN	Drain of the internal power MOSFET
6	DRN	Drain of the internal power MOSFET
7	NC	Not connected.
8	CS	Input current sense pin

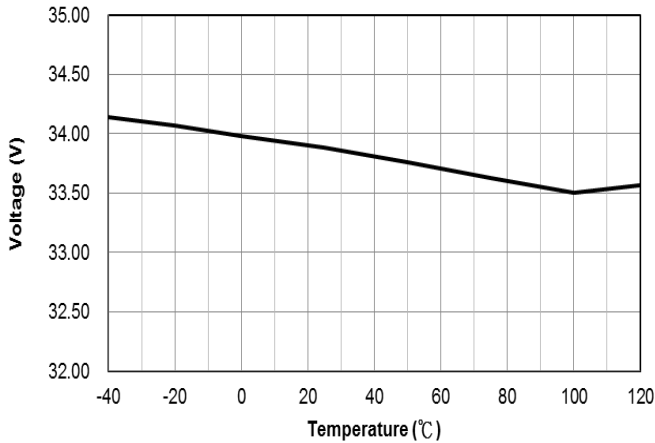
**CHARACTERISTICS CURVES**



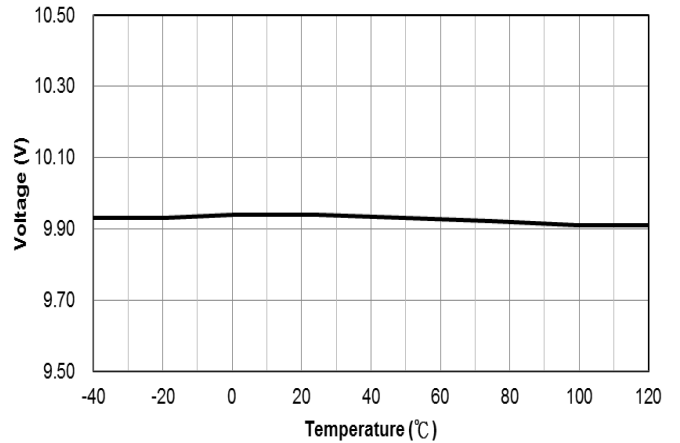
**Figure 1 -  $V_{CC\_ON}$  vs. Junction Temperature**



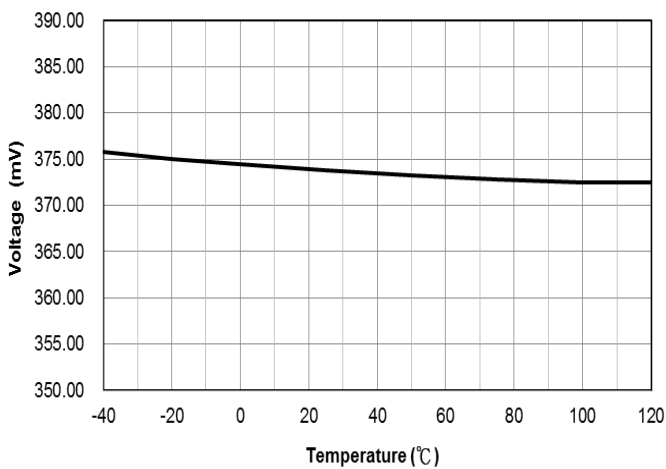
**Figure 2 -  $V_{CC\_OFF}$  vs. Junction Temperature**



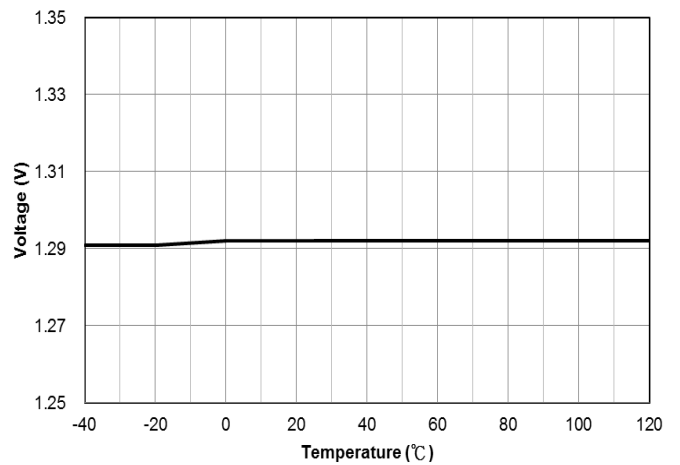
**Figure 3 -  $V_{OVPA}$  vs. Junction Temperature**



**Figure 4 -  $V_{OVPS}$  vs. Junction Temperature**



**Figure 5 -  $V_{REF}$  vs. Junction Temperature**



**Figure 6 -  $V_{OCP}$  vs. Junction Temperature**

## APPLICATION INFORMATION

### Function Description

The TS19706CS is configurable for either isolated primary side Flyback regulation or non-isolated buck-boost current regulation topologies. The IC active power factor correction in Flyback mode and achieves constant current accuracy and low total harmonic distortion (THD) using Boundary Conduction Mode (BCM) operation. An integrated 630V switching MOSFET reduces the external components required for application implementation. The TS19706CS has built-in  $V_{CC}$  over voltage protection, open LED protection, short LED protection, over temperature protection, and primary-side current limit.

The average output current can be expressed as below.

$$I_{OUT\_avg} = \frac{N_P}{N_S} \times \frac{0.370 * \eta}{2 \times R_S}$$

Where:

- $I_{OUT\_avg}$  is the average output current
- $N_P$  is the primary-side turn ratio
- $N_S$  is the secondary-side turn ratio
- $\eta$  is the efficiency
- $R_S$  is the sensing resistor connected between the MOSFET source and the GND

### Pin Definitions

#### **COM (Compensation)**

This is the output of the  $g_m$  amplifier. Connect with a suitable RC network to ground.

#### **GND (Ground)**

GND is the reference node of internal circuit.

#### **CS (Current Sense)**

MOSFET current signal sensing for multiplication and current limit setting function.

$$I_{CS(LIMIT)} = \frac{1.35}{R_S}$$

Where:

- $I_{CS(LIMIT)}$  is the input current sense
- $R_S$  is the sensing resistor connected between the MOSFET source and GND

#### **DRN (Drain)**

Internal Power MOSFET Drain.

#### **$V_{CC}$**

Power supply for the controller during normal operation. The controller will start up when  $V_{CC}$  reaches 15.3V (typical) and will shut-down when  $V_{CC}$  voltage is below 7.8V (typical). A decoupling capacitor should be connected between the  $V_{CC}$  and GND pin as close as possible.

The TS19706CS performs  $V_{CC}$  over voltage protection though  $V_{CC}$  pin. Once  $V_{CC}$  pin exceeds in 34V, TS19706CS turns off and latches out the MOSFET switcher until  $V_{CC}$  goes below  $V_{CC\_OFF}$ .

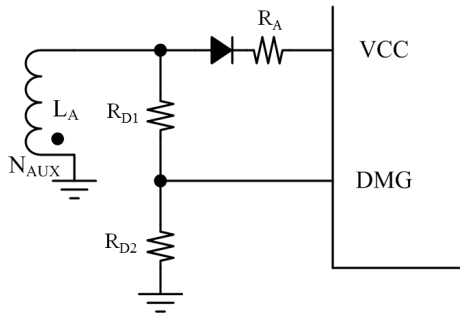
**APPLICATION INFORMATION (CONTINUE)**

**DMG (Zero Current Demagnetization)**

The output voltage is defined by the auxiliary winding ( $N_{AUX}$ ) of the fly-back transformer. The DMG pin senses output information to protect against undervoltage ( $V_O < V_{O\_STR}$ ) and overvoltage ( $V_O > V_{O\_OVP}$ ).

When the DMG senses voltage under  $V_{O\_STR}$  the circuit will operate in short circuit protection mode,  $f_{STR}=1/t_{STR}$ .

When the DMG senses voltage over  $V_{O\_OVP}$ , the circuit will implement over-voltage protection latch until  $V_{CC}$  goes below  $V_{CC\_OFF}$ .



$$V_{O\_OVP} = \frac{N_{SEC}}{N_{AUX}} \times V_{OVPS} \times \frac{R_{D1} + R_{D2}}{R_{D2}}$$

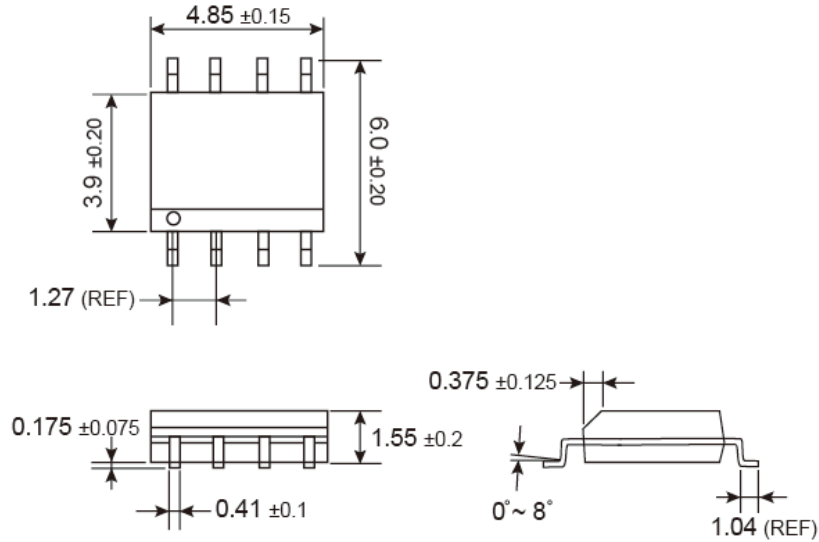
$$V_{O\_STR} = \frac{N_{SEC}}{N_{AUX}} \times 3 \times \frac{R_{D1} + R_{D2}}{R_{D2}}$$

Where :

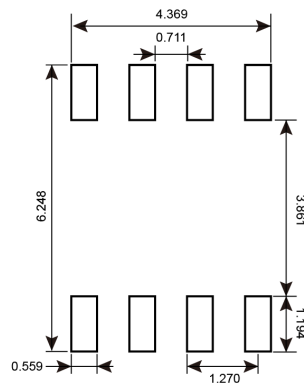
- $V_{OUT\_OVP}$  is the output-over-voltage protection point
- $V_{OVPS}$  is the over voltage protection signal
- $V_{O\_STR}$  is the start-up timer
- $N_{AUX}$  is the number of auxiliary-winding turns
- $N_{SEC}$  is the number of secondary-winding turns

**PACKAGE OUTLINE DIMENSIONS** (Unit: Millimeters)

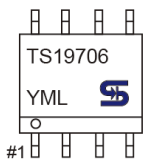
**SOP-8**



**SUGGESTED PAD LAYOUT** (Unit: Millimeters)



**MARKING DIAGRAM**



- Y** = Year Code
- M** = Month Code for Halogen Free Product
  - O** =Jan
  - P** =Feb
  - Q** =Mar
  - R** =Apr
  - S** =May
  - T** =Jun
  - U** =Jul
  - V** =Aug
  - W** =Sep
  - X** =Oct
  - Y** =Nov
  - Z** =Dec
- L** = Lot Code (1~9, A~Z)



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