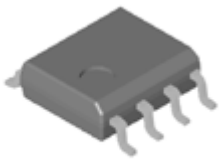
RED2822

RED2822 PSR Dimming LED Controller

Features

- Primary side LED dimming controller
- Linear CC dimming down to 1% possible
- PWM dimming possible for better accuracy
- +/-3% Primary Side Regulation of LED current with no Flicker
- 50% duty cycle, variable frequency control of resonant half-bridge
- Suitable for use with digital or analogue Dimming control modules
- Protection modes:
  - Short-circuit
  - No-Load
  - Over-temperature current foldback
- No flicker



Small SO8 package

Applications

- Linear dimmable LED drivers without flicker
- Low-cost passive PFC LED drivers <80W
- High power universal mains input LED drivers <250W

Order code

Part Number	Package	Packaging
RED2822AD-TR13	SO8	Tape and reel

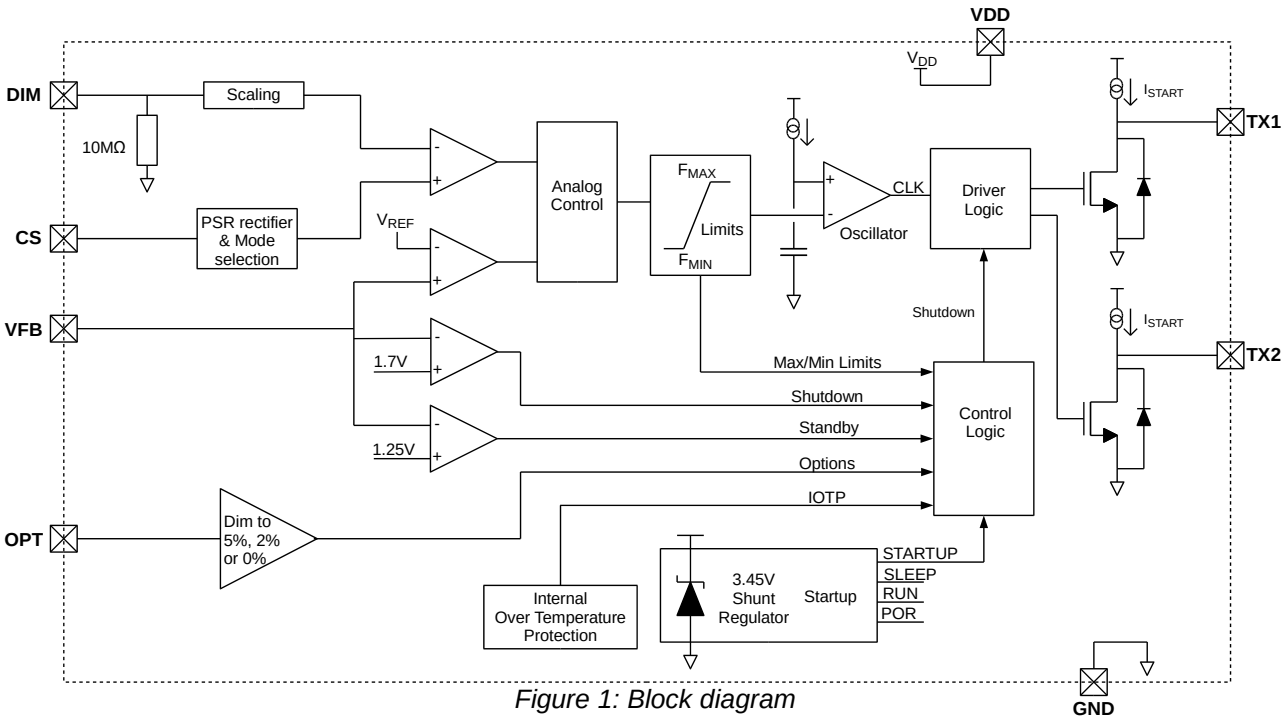


Figure 1: Block diagram

Device Pins

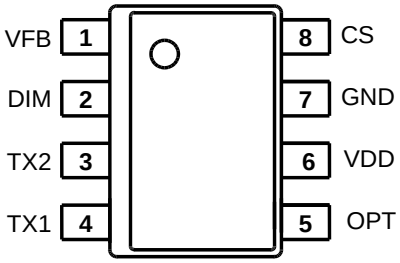


Figure 2: SO8 pin connections (top view)

Pin Functions

Pin #	Name	Function
1	VFB	PSR Feedback input for output voltage regulation. Connect to primary sense winding.
2	DIM	Between 0V and V_{DD} the output current varies linearly from 0% to 100%
3	TX2	Output to control transformer
4	TX1	Output to control transformer
5	OPT	Options pin for selecting off function on the DIM pin
6	VDD	IC Power Supply pin – nominally 3.45V
7	GND	Chip ground.
8	CS	Resonant current waveshape detection for protection features such as overcurrent & capacitive mode. The CS pin is connected to the half-bridge current sense resistor.

Typical Application

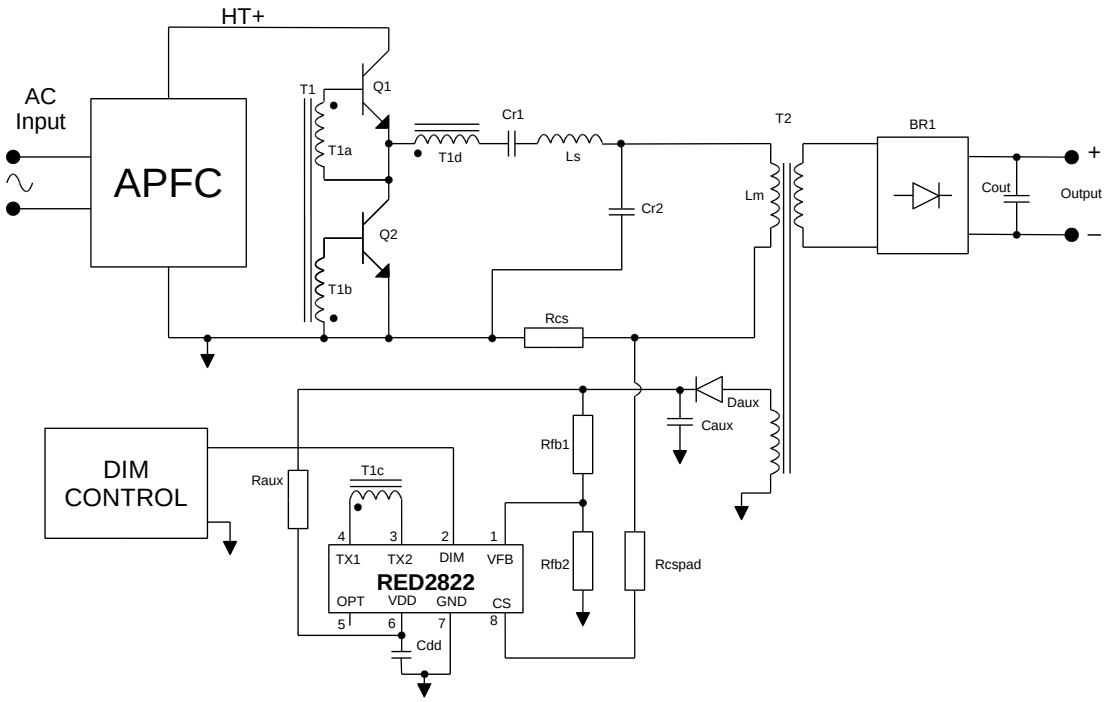


Figure 3: Typical Application: LED driver using RED2822 *LCC controller*

Features

RED2822 is an advanced CMOS control IC for resonant converters. The patented RED2822 Primary Side Regulation control scheme accurately controls the LED current so that accurate dimming can be achieved.

RED2822 uses the CSOC (Controlled Self-Oscillating Converter) scheme to drive two low-cost bipolar transistors in a half-bridge configuration. RED2822 is optimized to work with RediSem's patented Passive PFC technology as well as with most APFC controllers.

Please contact RediSem for application design information for LED drivers with passive or active PFC.

Accurate Current Regulation

The RED2822 regulates the LED drive current by keeping the CS pin voltage regulated to a level set by the DIM pin voltage. In this way, the accuracy of the dim signal is directly proportional to the accuracy of the output current level.

Voltage Regulation

With a faulty or disconnected LED, the RED2822 controls the maximum output voltage using primary side voltage regulation, overriding the DIM pin. To minimise input power in this condition, the IC should be shut down by pulling the VFB pin high.

Protection Features

The IC is able to detect a number of faults that cause the IC to enter a fault mode:

- Output short circuit
- Resonant inductor shorted
- Over-temperature current foldback

During these fault conditions, the IC will continually attempt to re-start. Between each re-start attempt there will be 16 dummy re-starts when the IC re-starts while the converter is off.

If the output is a short-circuit, the IC detects this and runs at fmax. If the fault is removed, the IC will

automatically return to the output current set by the DIM input.

The IC also has an instantaneous cycle-by-cycle over-current protection (OCP) level that will terminate any cycle instantaneously should the current exceed a pre-set level.

Over-temperature Foldback

The RED2822 Over-temperature foldback occurs when the IC temperature reaches 125°C. Between 125°C & 130°C the IC reduces the output current from the current dim level setting down to 0%.

Automatic Dead-Time Control

An important feature of the Controlled Self Oscillating Converter is that the dead-time is controlled naturally. Unlike MOSFET half-bridge converters, it is not necessary to program the dead-time on RED2822. The bipolar switching transistors are turned on correctly through the self-oscillation of the converter and turned off by RED2822. This greatly simplifies the design process and improves the robustness of the resonant converter.

Capacitive Mode Protection

RED2822 includes a capacitive mode protection feature which prevents the converter from entering capacitive switching mode on a cycle-by-cycle basis by limiting the minimum frequency. This always ensures the Controlled Self Oscillating Converter continues to oscillate correctly.

Oscillator

The RED2822 includes an internal oscillator which is used to control the switching frequency of the converter. The maximum and minimum frequency limits are pre-set inside the IC and have been chosen to suit a low power CSOC converter. The oscillator ramp is compared to an internal control voltage to produce the correct frequency required to regulate the converter.

IC Operation

VDD and GND pins

With a low voltage between VDD and GND the IC is in SLEEP mode. In SLEEP mode the IDD current is approximately 8uA ($I_{DDSLEEP}$). Once VDD reaches 3.7V ($V_{DDSTART}$) the IC wakes up and enters STARTUP mode. During the initial period of approximately 40ms (8192 cycles) VDD is allowed to drop to 2.4V. This gives time for the application to pull up the output voltage. After this the IC enters RUN mode when the controlled Zener clamp inside the IC regulates the VDD voltage to 3.45V (V_{DDREG}). The IC current drawn is approximately 0.7mA (I_{DDREG}) plus any excess current required to clamp VDD to 3.45V. If VDD falls below 3.45V (V_{DDREG}) the Zener clamp turns off and I_{DD} reduces to 0.7mA (I_{DDREG}) only. If VDD falls below 3.0V ($V_{DDSLEEP}$), the IC enters SLEEP mode. In this condition I_{DD} reduces back to 8uA. ($I_{DDSLEEP}$).

Because the IC is shunt regulated, feed power to the IC through a resistor. Connect a capacitor between VDD and GND of at least 100nF. The capacitor should be located close to the pins. To ensure the IC does not turn on after a power-down, add a resistor between VDD and GND. A diagram of the connection circuit can be seen in Figure 4.

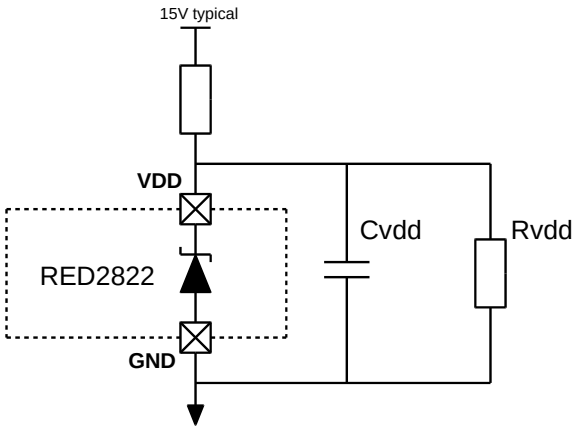


Figure 4: VDD & GND connections

TX pins

A diagram of the output stage can be seen in Figure 5. To start the converter oscillating the RED2822 issues start pulses through the TX pins during the first two cycles. These start pulses are 800ns long ($t_{TXSTART}$) and provide 8mA ($I_{TXSTART}$) for APFC mode; 16mA ($I_{TXSTART}$) for PPFC mode current pulses from both TX1 and TX2 pins. After this the converter self-oscillates and no longer needs start pulses to maintain oscillation. A low on-state NMOS transistor is used to turn the bipolar transistors off. It is controlled by the oscillator off-time. The NMOS device is turned to pull TX pin low, which switches off the corresponding bipolar transistor in the power converter half-bridge.

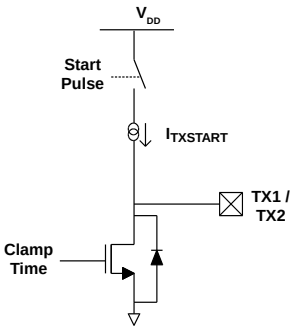


Figure 5: TX pins

VFB pin

RED2822 features an internally compensated CV control loop to control the maximum LED converter output voltage. The VFB input senses the output voltage from an auxiliary winding on the primary side of the transformer. This signal is conditioned in the PSR block and compared to a voltage reference of 1.20V (VREF) inside the IC.

In CV mode the VFB pin is regulated to VREF by adjusting the internal control voltage and therefore the converter operating frequency. If the VFB pin voltage exceeds 1.25V [VFBSTBY], RED2822 will go into STANDBY. When VFB voltage drops to 0.85V Tx pulses will resume.

In a constant current LED application the VFB voltage will normally be below the 1.2V regulation point VREF as the CC control loop determines the control voltage. If the LED voltage is too high, or the LED becomes disconnected, the CC loop is not in control and the VFB voltage will exceed 1.2V VREF control voltage. At that point the frequency of the RED2822 will increase until the IC goes into standby.

If the VFB pin is exceeds 1.7V[VFBSDN]. IC will shutdown and reset. The IC will restart again when VFB drops below 0.85V.

A diagram of the circuit in and around the VFB pin can be seen in figure 6.

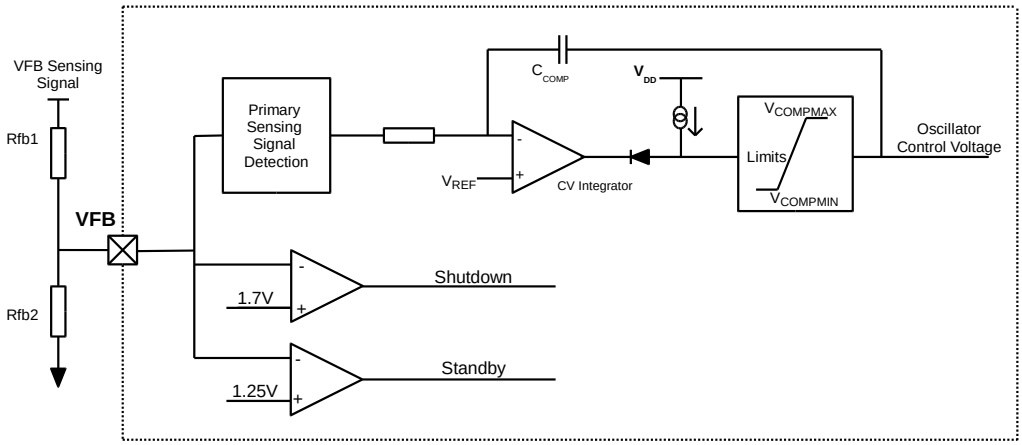


Figure 6: Voltage Error Amplifier Circuit

OPT pin

The OPT option pin of RED2822 controls the dim-to-off function of the DIM pin. This is particularly useful when RED2822's DIM pin is controlled by a simple PWM signal. When the filtered PWM signal on the DIM pin drops below a preset threshold, the RED2822 will enter Standby. In Standby RED2822 enables a power saving mode where a short ON duty cycle maintains power to the IC, without illuminating the LED load. Table 1 shows how the OPT pin sets the dim-to-off level on the DIM pin.

OPT pin voltage	DIM pin standby level
½ V_{DD} (floating)	<5 % dim level
V_{DD}	<2 % dim level
GND	Standby disabled

Table 1: Standby configuration with OPT pin

CS pin

The primary function of the CS pin is to control the LED driver output current. The CS pin is connected to a resistor in the series resonant current path. The resistor value should be chosen to give an average voltage of 150mV [V_{CCREG}] at full output current. RED2822 gathers information from the waveshape to ensure protection in capacitive mode operation and ensuring correct commutation at low dim levels.

The CS pin also includes an instantaneous Over-Current Protection (OCP) by terminating the current oscillator cycle and the transistor on-time. When a peak voltage occurs that exceeds the OCP threshold 700mV [V_{OCPTHR}] the OCP comparator terminates the current oscillator on-time cycle. The oscillator is reset and the off-time begins resulting in the bipolar transistors turning off and the half-bridge commutating. This is repeated in subsequent cycles whenever the CS voltage exceeds the OCP threshold. Note that in a correctly designed converter it should not be possible to trip OCP in normal operation.

The CS padding resistance R_{CSPAD} (see figure 7) is used to select the converter configuration mode. If R_{CSPAD} ≤ 100ohm, RED2822 will be configured for an active PFC converter design (APFC mode). If R_{CSPAD} >200 Ohm, RED2822 is configured for a passive PFC system (PPFC mode).

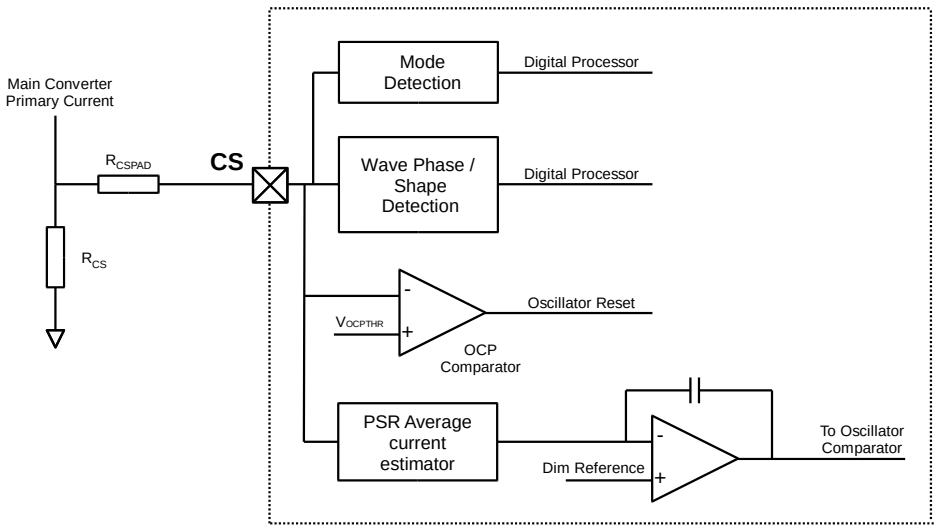


Figure 7*: CS Pin connection*

DIM pin

RED2822's DIM pin controls the LED driver output current level, which is set by the R_{CS} resistor on the CS pin. The LED driver output current can be varied from 100% down to nearly 0% as the DIM pin varies from 3.3V to 0V.

The DIM pin dim-to-off function is configured by the OPT pin (see OPT pin section).

A graph showing the relationship between the LED driver output current and the DIM pin voltage is given in figure 9.

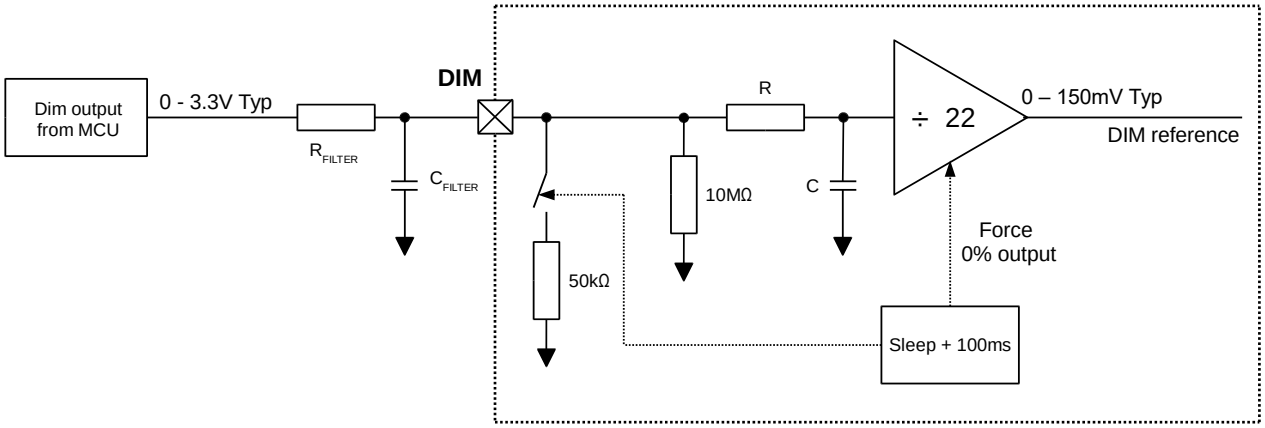


Figure 8*: RED2822 DIM pin circuit*

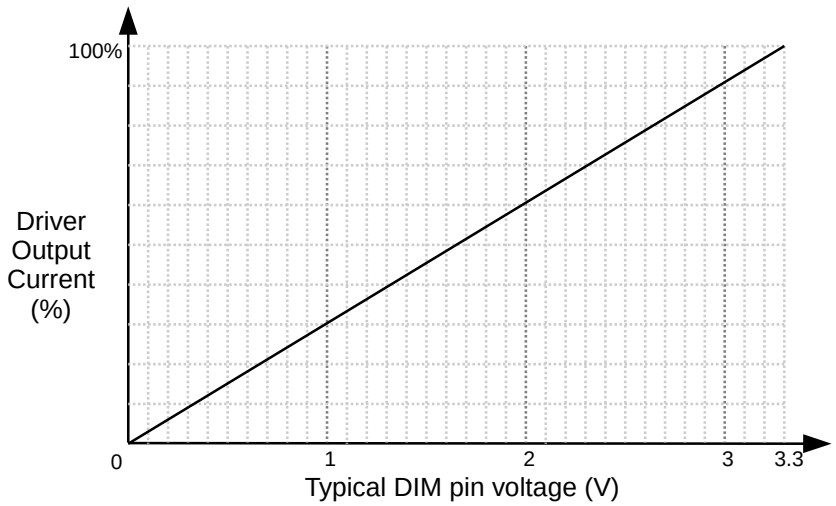


Figure 9*: DIM pin voltage vs output current*

ABSOLUTE MAXIMUM RATINGS

CAUTION: Permanent damage may result if a device is subjected to operating conditions at or in excess of absolute maximum ratings.

Parameter	Symbol	Condition	Min	Max	Unit
Supply voltage	V_{DD}	SLEEP mode: self-limited by IC start-up ($V_{DDSTART}$)	-0.5	4.5	V
Supply voltage	V_{DD}	RUN mode: Self-limited by internal shunt regulator	-0.5	4.0	V
Supply current	I_{DD}		0	10	mA
Input/output voltages	V_{IO}		-0.5	V_{DD} + 0.5	V
Input/output currents	I_{IO}		-10	10	mA
Junction temperature	T_J	T_{J_MAX} limited by OTP (T_{OTPS_MAX})	-25	+135	°C
Storage temperature	T_P		-25	+125	°C
Lead temperature	T_L	Soldering, 10 s		260	°C
ESD withstand		Human body model, JESD22-A114		2	kV
		Capacitive Discharge Model		500	V

NORMAL OPERATING CONDITIONS

Unless otherwise stated, electrical characteristics are defined over the range of normal operating conditions. Functionality and performance is not defined when a device is subjected to conditions outside this range and device reliability may be compromised.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Minimum supply current	I_{DDMIN}		0.8	1.0	1.2	mA
Junction temperature	T_J		-25	25	125	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise stated:

- Min and Max electrical characteristics apply over normal operating conditions.
- Typical electrical characteristics apply at $T_J = T_{J(TYP)}$ and $I_{DD} = I_{DDREG(TYP)}$.
- The chip is operating in RUN mode.
- Voltages are specified relative to the GND pin.

VDD Pin

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage	$V_{DDSTART}$	Enter RUN mode from SLEEP	3.2	3.7	4.2	V
	V_{DDREG}	$I_{DD} < I_{DDSHUNT}$	3.3	3.45	3.6	V
	$V_{DDSLEEP}$	To enter SLEEP mode	2.85	3.0	3.15	V
Supply current	I_{DDREG}	In RUN mode, VDD<VDD_{REG}		0.7	0.8	mA
	$I_{DDSLEEP}$	In SLEEP mode		8	12	µA
	$I_{DDSHUNT}$	VDD shunt regulator max current			8	mA

VFB Pin

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Regulation voltage	V_{REF}		1.15	1.20	1.25	V
Standby threshold	V_{FBSTBY}			1.25		V
Shutdown threshold	V_{FBSDN}			1.7		V

CS Pin

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Minimum Constant current regulation	$V_{CCREG(MAX)}$	DC CS signal. DIM pin = 3.3V		150		mV
Minimum Constant current regulation	$V_{CCREG(2\%)}$	DC CS signal. DIM pin = 66mV OPT pin = Vdd		3		mV
Minimum Constant current regulation	$V_{CCREG(5\%)}$	DC CS signal. DIM pin = 165mV OPT pin floating		5.5		mV
Instantaneous over-current protection threshold	V_{OCPTHR}			700		mV

Oscillator

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Minimum Frequency	F_{MIN}			42		kHz
Maximum Frequency	$F_{MAXAPFC}$	Rcspad ≤100ohm		295		kHz
Maximum Frequency	$F_{MAXPPFC}$	Rcspad >200ohm, OPT(0%) or OPT(2%)		240		kHz
Low Maximum Frequency	$F_{MAXPPFC,low}$	Rcspad >200ohm, OPT(5%)		210		kHz

OPT Pin

Parameter	Symbol	Condition	Min	Typ	Max	Unit
No Off voltage	$V_{OPT(0\%)}$		0		0.5	V
2% Off voltage	$V_{OPT(2\%)}$		V_{DD} - 0.5		V_{DD}	V
5% Off voltage	$V_{OPT(5\%)}$		1		2.5	V

DIM Pin

Parameter	Symbol	Condition	Min	Typ	Max	Unit
100% input voltage	V_{DIMMAX}			3.3		V
2% off threshold	V2%	OPT pin connected to VDD		66		mV
5% off threshold	V5%	OPT pin is floating		165		mV
Input impedance	R_{DIM}*			10		MΩ

TX1, TX2 Pins

Parameter	Symbol	Condition	Min	Typ	Max	Unit
On-state resistance	R_{TXON}			1.0	1.5	Ω
TX pin clamp current	$I_{TXCLAMP}$*	TX pin frequency >30kHz			800	mA
Start-pulse output current	$I_{TXSTARTAPFC}$*	TX pin voltage 2V, APFC mode		8		mA
Start-pulse output current	$I_{TXSTARTPPFC}$ *	TX pin voltage 2V, PPFC mode		16		mA
Start-pulse width	$T_{TXSTART}$			800		ns

*Over-Temperature Protection (OTP) **

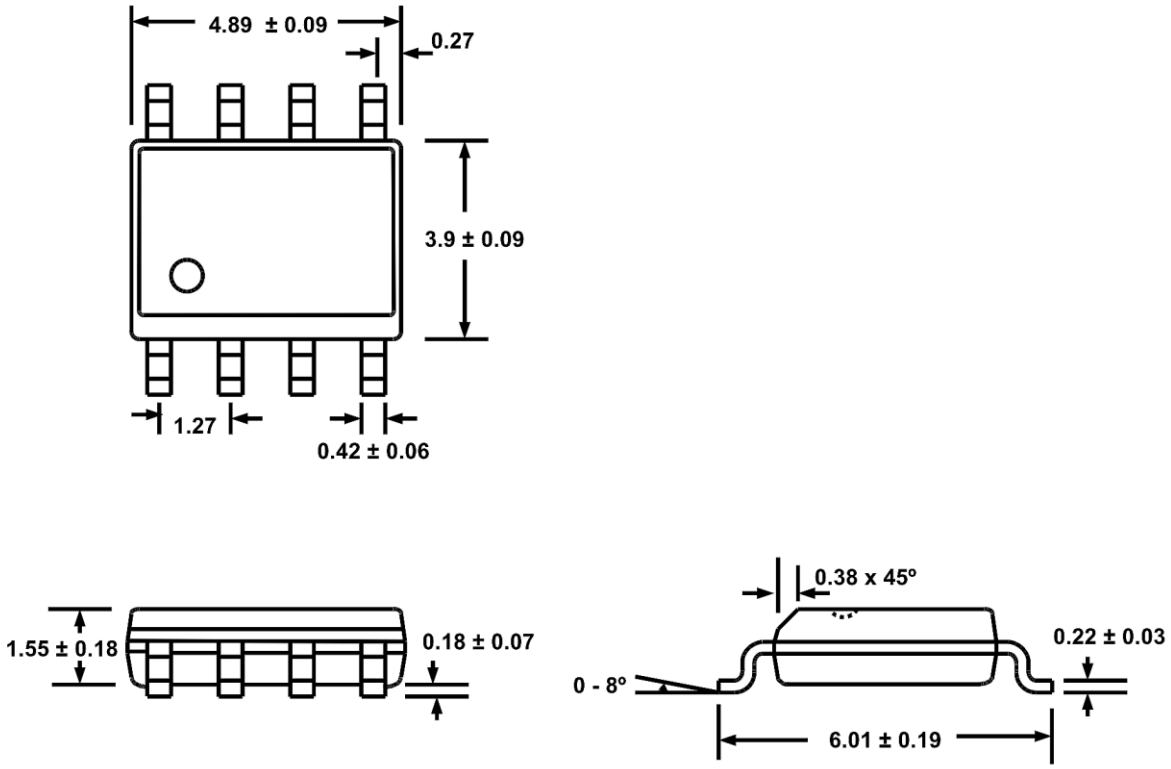
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Over-Temperature Foldback threshold	T_{OTFS}	At silicon junction	115	125	135	°C

***: not tested in production*

PACKAGE INFORMATION

Package Dimensions

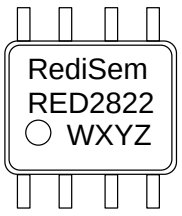
SO8N package dimensions are shown below. All units are in mm.



Available packages

Package type	Part number	Moisture Sensitivity Level (MSL)	Packaging	Thermal Resistances		
SO8	RED2822AD-TR13	3 (JEDEC J-STD-020)	Tape and reel 2500pcs/13" reel	Junction - Lead	θ_{JL}	30°C/W
				Junction - Ambient	θ_{JA}	150°C/W

Package Marking



SO8 top-side marking for RED2822

RED2822= Part Number

WXYZ= Lot Code, e.g. AAAA, AAAB

Status

The status of this Datasheet is shown in the footer.

Datasheet Status	Product Status	Definition
Preview	In development	The Datasheet contains target specifications relating to design and development of the described IC product.
Preliminary	In qualification	The Datasheet contains preliminary specifications relating to functionality and performance of the described IC product.
Production	In production	The Datasheet contains specifications relating to functionality and performance of the described IC product which are supported by testing during development and production.

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