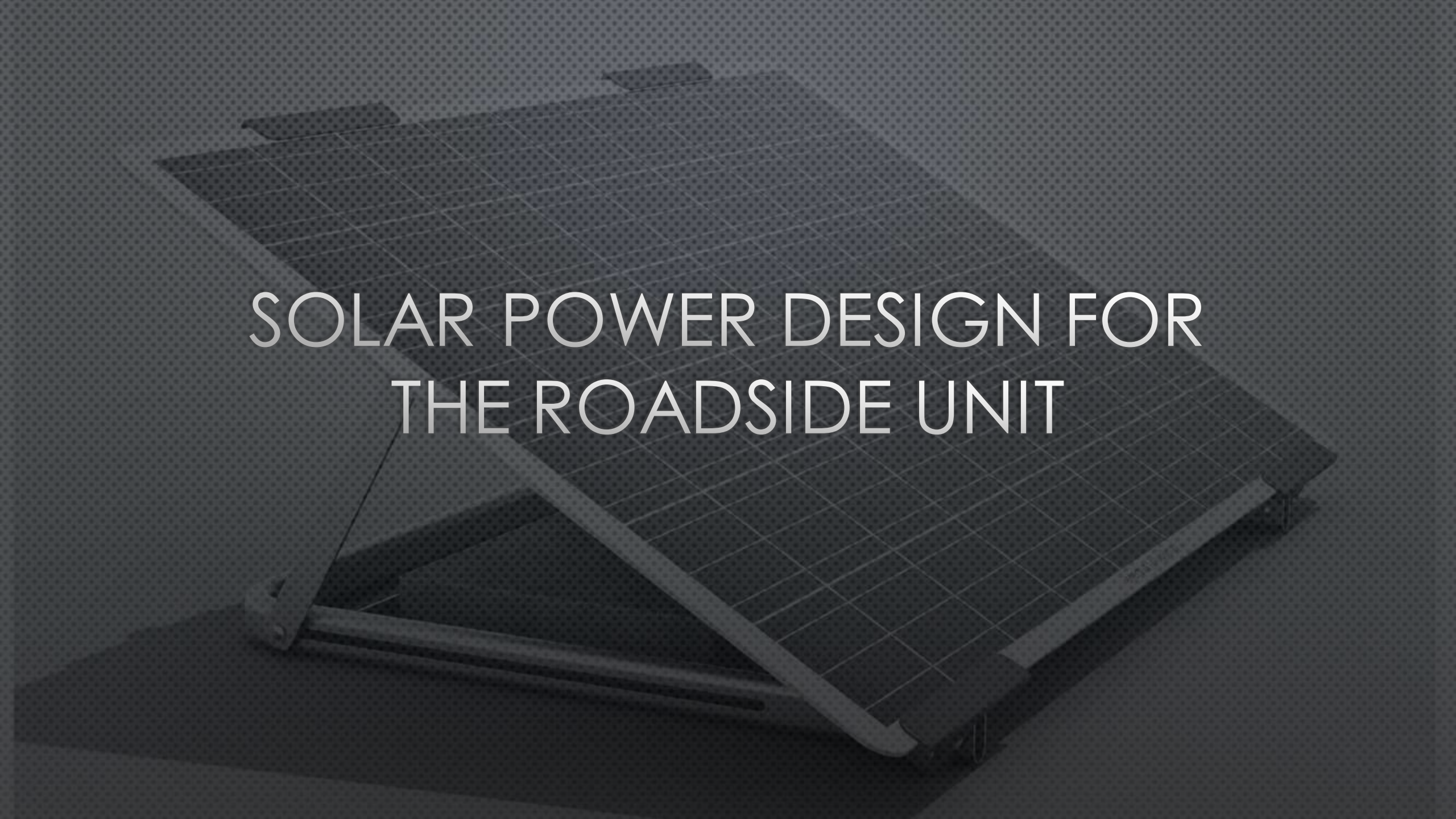


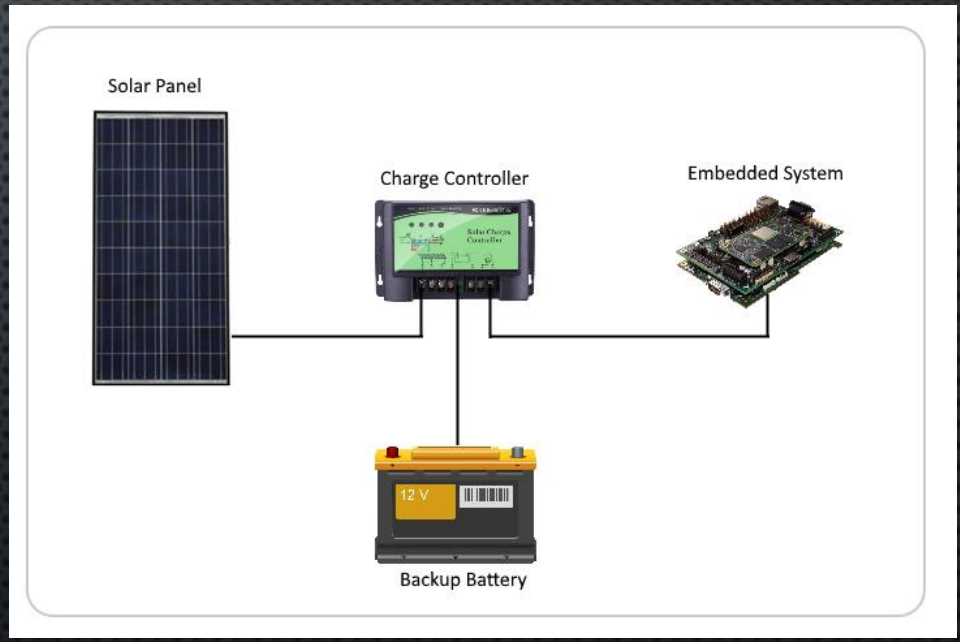
SOLAR POWER DESIGN FOR THE ROADSIDE UNIT

Overview

- Solar power components
- System power consumption
- Solar Panel Sizing
- Battery Sizing
- Charge Controller
- Installation concept

Solar Power Components

- 12V Solar Panel, 8-18V depending on sunlight
- Charge Controller, Max Power Point Tracking (MPPT)
- 5V Embedded System as load
- 12V, SLA or LiFePO4



SYSTEM POWER CONSUMPTION

5 WATTS WHILE TRANSMITTING DATA, 1W WHILE AT IDLE

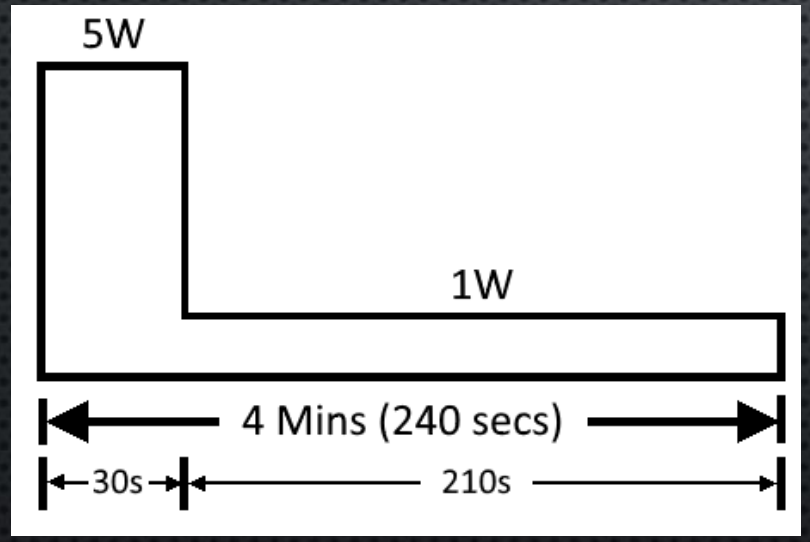


Fig 1: Power consumption cycle of the roadside unit

$$P_{avg} = \frac{1}{240s}[(5W * 30s) + (1W * 210s)]$$
$$= \frac{360Ws}{240s}$$
$$= 1.5W$$

$$E_{avg\ per\ day} = P_{avg} * 24hrs$$
$$= 1.5W * 24hrs$$
$$= 36Wh$$

THEREFORE, THE ROADSIDE SYSTEM ON AVERAGE CONSUMES **36WH PER DAY**

BATTERY BANK SIZING

- System Power consumption = 36Wh / day
- We want the system to function even with 2 continuous days without sun
- We want to discharge only to 50% to prolong life of battery
- Assuming 21°C and 12V battery

$$P_{bat} = \frac{36Wh * 2}{0.5} = 144Wh$$

$$I_{bat} = \frac{144Wh}{12V} = 12Ah$$

Therefore, the battery must have at least **144Wh capacity (12Ah at 12V)**

Note capacity should be ~1.5-2 times the above capacity for sub zero temperatures due to charge performance

Battery Comparisons

LiFePO4

- Popular in vehicle applications
- Stable and safer then LiCoPO4
- >10 year lifetime, 2000 cycles
- 3.2V nominal until exhausted
- 70% apparent capacity at -20°C
- Impractical charge rates below freezing (0.02-0.05C), would need a thermal blanket

Sealed Lead-Acid

- Big and sluggish, takes a long time to fully charge (70% in 5-8 hours)
- 70% retention capacity after 5 years @ 21°C
- Can charge at 0.3C between -20°C to 50°C

SOLAR PANEL SIZING

- SIZING BASED OFF POWER CONSUMPTION AND WORST MONTH OF SUNSHINE IN AREA
- WORST CASE IN TORONTO IS DECEMBER
- 2.5 HOURS AVERAGE SUN PER DAY
- ADD 30% FOR INEFFICIENCIES

Sun

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Total hours bright sunshine	88	110	156	185	229	256	276	241	188	148	84	75
Days with measurable bright sunshine	21	21	24	26	28	28	30	30	27	27	20	19
Extreme daily bright sunshine hours	9	10	12	13	15	15	14	14	12	10	10	9
Date	Jan 22 1989	Feb 20 1972	Mar 27 1973	Apr 22 1975	May 30 1996	Jun 26 1999	Jul 19 1997	Aug 04 1972	Sep 01 1986	Oct 20 1986	Nov 04 1975	Dec 01 1971

https://www.theweathernetwork.com/forecasts/statistics/suncloud/cl6158350/caon0696

$$\text{Solar Panel Wattage} = 1.3 * \frac{36Wh}{2.5h} = 18.72W$$
$$= 20W$$

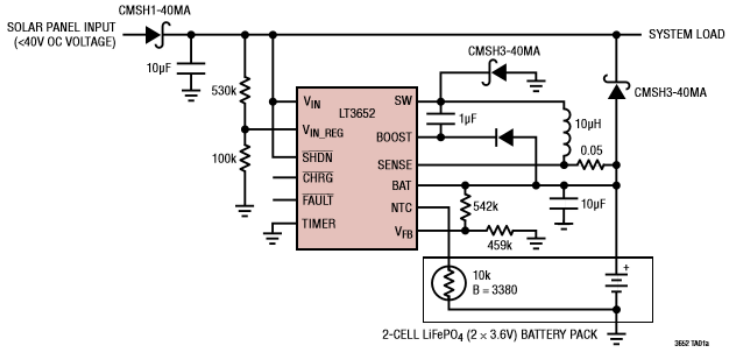
Therefore, a **20W solar panel** is needed.

CHARGE CONTROLLER

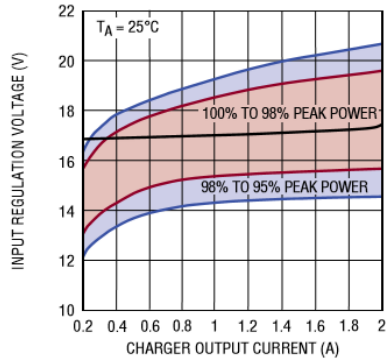
- LT3652 – Power Tracking 2A Battery Charger for Solar Power
- 5-32V input, 2A charge rate
- Accommodates LiPo, LiFePo4, and SLA
- Employs MPPT (Maximum power point tracking), which adjusts the panel voltage to match the battery charge voltage for maximum power

TYPICAL APPLICATION

2A Solar Panel Power Manager With 7.2V $LiFePO_4$ Battery and 17V Peak Power Tracking



Solar Panel Input Voltage Regulation, Tracks Max Power Point to Greater Than 98%



http://cds.linear.com/docs/en/datasheet/3652fe.pdf

INSTALLATION CONCEPT