Application Note AN200

Open Dots® Power Tool Battery Chargers

Introduction

Open Dots™ surface energy technology is ideal for charging power tools batteries for many reasons. They are the same reasons the power surface is called a Plugless Power Strip™.

Figure 1

For starters, power tool batteries of any shape, size, and brand will charge when placed anywhere on an *Open Dots*™ power surface. The *Open Dots*™ technology employs no electromagnetic fields to fear. The near 100% efficiency of the *Open Dots*™ technology ensures cool, reliable operation unattainable by any other technology – it is in a category all its own. What's more, any other *Open Dots*™ product can operate on the power surface at the same time.

For this application, a throttle circuit is used so that the battery can also charge power surfaces of lower power. In case an *Open Dots*™ power tool battery is placed on a power surface of lower-power, the charge controller circuitry in the battery reduces the charge current to prevent shutting down the low-power pad.

This application note details how power tools can be easily enabled for use with *Open Dots*™ pads.

Block Diagram

An *Open Dots*™ power tool battery charging circuit is comprised of three main elements as shown in the block diagram of figure 2.

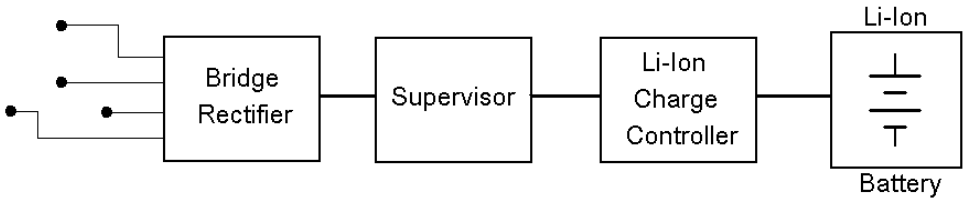


Figure 2

We first investigate the general power requirements of this application. Typical power tool batteries are 20V (5 cell) with a capacity of typically 1.5 Ah. Plug-in wall chargers in the industry are typically 1C and sometimes 2C chargers corresponding to charge times of 1 hour or 30 minutes respectively. A 1 hour charger, therefore, consumes about 30 Watts of power. When the battery is placed on a low-power pad, we define that the charge rate will drop to 1/3 C – a 3 hour charge rate. We next discuss each block of Figure 2 successively.

At a power level of 30 Watts, it is a good idea to use an active bridge rectifier. An active bridge rectifier has very low loss compared to a passive rectifier at this power level. A passive, Schottky-diode-based rectifier could work depending on the heat-sinking employed in order to prevent the reverse current from getting too high. Nevertheless, for the purpose of this application note, we assume an active bridge rectifier is used.

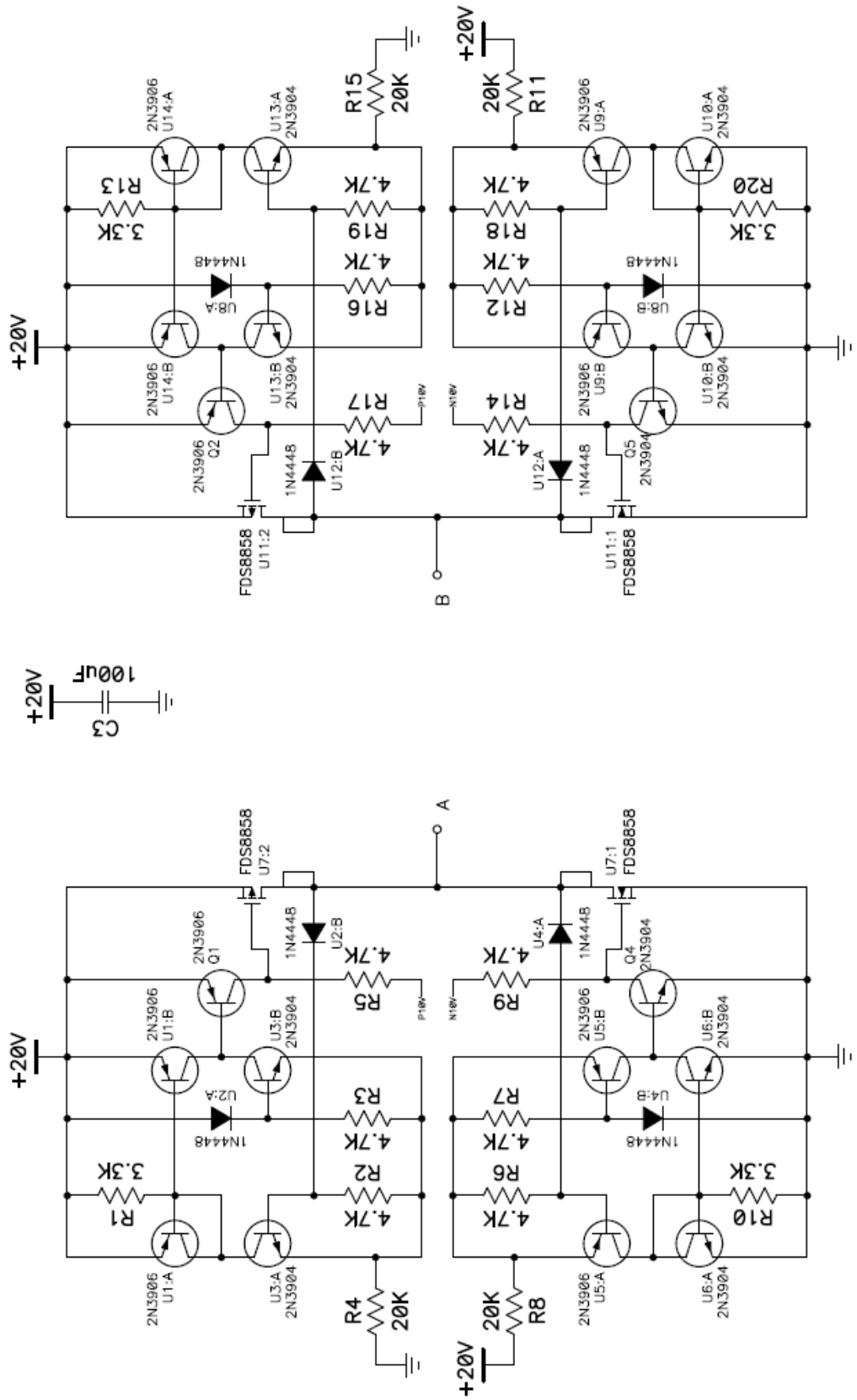
The supervisor circuit performs three simple functions. This module implements a turn-on delay as a soft start. It further senses the pad voltage and appropriately throttles the charge rate so that charging can continue even on a low-power pad.

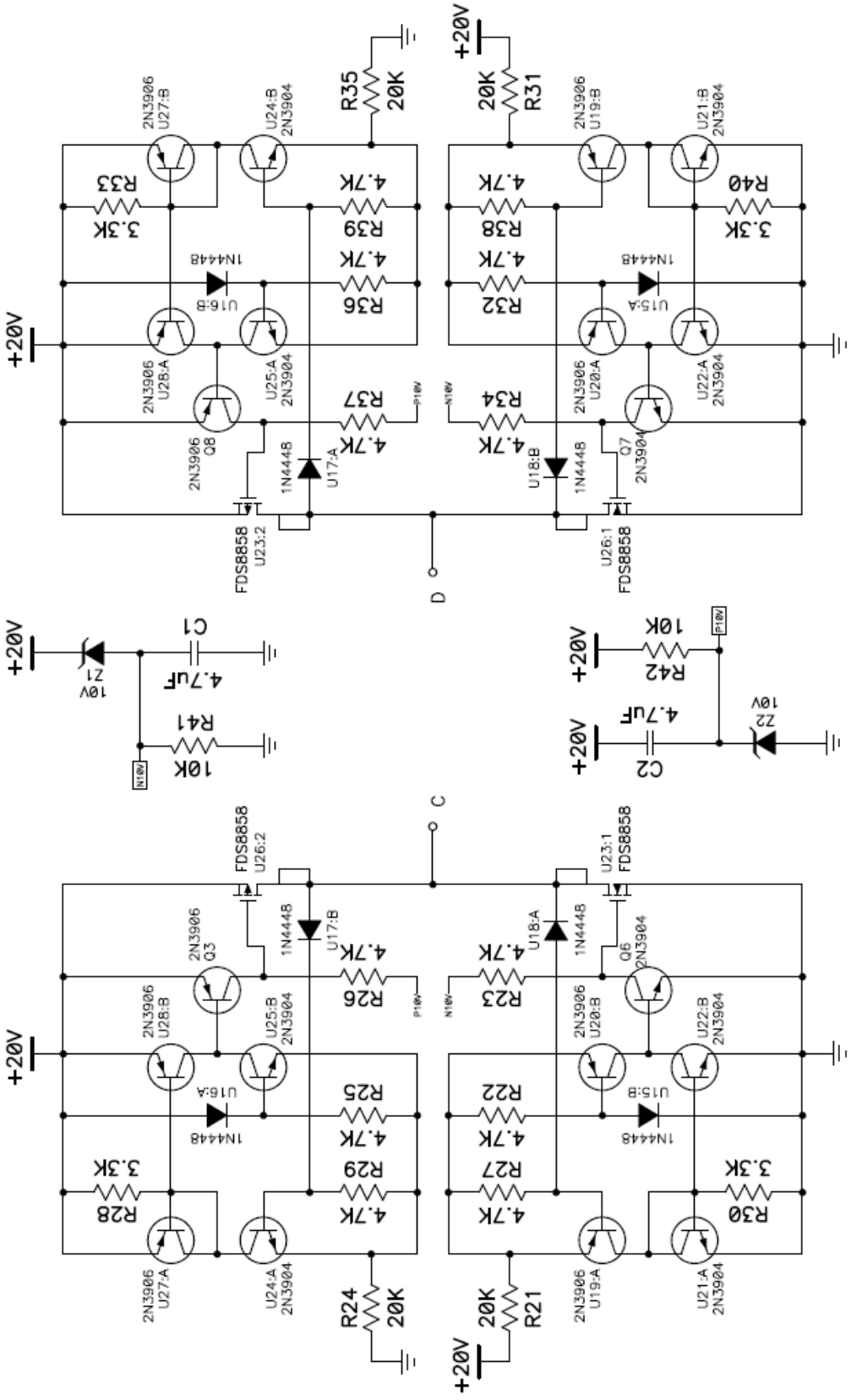
The charge controller provides a switching regulator and a charge algorithm to optimize the charge rate and keep the battery safe. A highly integrated charge controller chip is used in this application note.

Active Bridge Rectifier

The schematic for an active bridge rectifier is provided in the figures below.

It is worth noting that the *Open Dots*™ Alliance is actively soliciting silicon vendors to integrate the active rectifier circuit into a highly integrated solution, thereby greatly simplifying the below schematics. This effort is strengthened with each additional *Open Dots*™ Alliance membership that signs on.


+20V
20K
R11
R15
20K
2N3906
U9:A
U14:A
U13:A
2N3904
U10:A
2N3904
4.7K
R18
R19
R20
3.3K
R13
1N4448
U8:B
U8:A
R12
R16
2N3906
U9:B
U14:B
U13:B
2N3904
U10:B
2N3904
R14
R17
4.7K
Q5
2N3904
Q2
2N3906
1N4448
U12:A
U12:B
FDS8858
U11:1
U11:2
B
C3
100UF
A
U7:1
U7:2
FDS8858
Q4
2N3904
Q1
2N3906
1N4448
U4:A
U2:B
R9
R5
2N3906
U5:B
U1:B
U3:B
2N3904
U6:B
2N3904
U4:B
U2:A
1N4448
R7
R3
R6
R2
R10
R1
3.3K
2N3906
U1:A
U3:A
2N3904
U6:A
2N3904
R4
20K
R8
20K
2N3906
U5:A


+20V
R35
20K
R31
20K
2N3906 U27:B
U24:B 2N3904
2N3906 U19:B
U21:B 2N3904
R33 3.3K
R39 4.7K
R38 4.7K
R40 3.3K
1N4448
U16:B
R36 4.7K
R32 4.7K
1N4448
U15:A
2N3906 U28:A
U25:A 2N3904
2N3906 U20:A
U22:A 2N3904
R37 4.7K
R34 4.7K
2N3906 Q8
1N4448
U17:A
U18:B
1N4448
Q7 2N3904
FDS8858 U23:2
FDS8858 U26:1
D
C1
4.7UF
10V Z1
R41 10K
R42 10K
C2
4.7UF
10V Z2
C
FDS8858 U26:2
FDS8858 U23:1
2N3906 Q3
1N4448
U17:B
U18:A
1N4448
Q6 2N3904
R26 4.7K
R23 4.7K
2N3906 U28:B
U25:B 2N3904
2N3906 U20:B
U22:B 2N3904
U16:A
1N4448
R25 4.7K
R22 4.7K
1N4448
U15:B
R28 3.3K
R29 4.7K
R27 4.7K
R30 3.3K
2N3906 U27:A
U24:A 2N3904
R24 20K
R21 20K
2N3906 U19:A
U21:A 2N3904

The charge controller is shown in Figure 3 below.

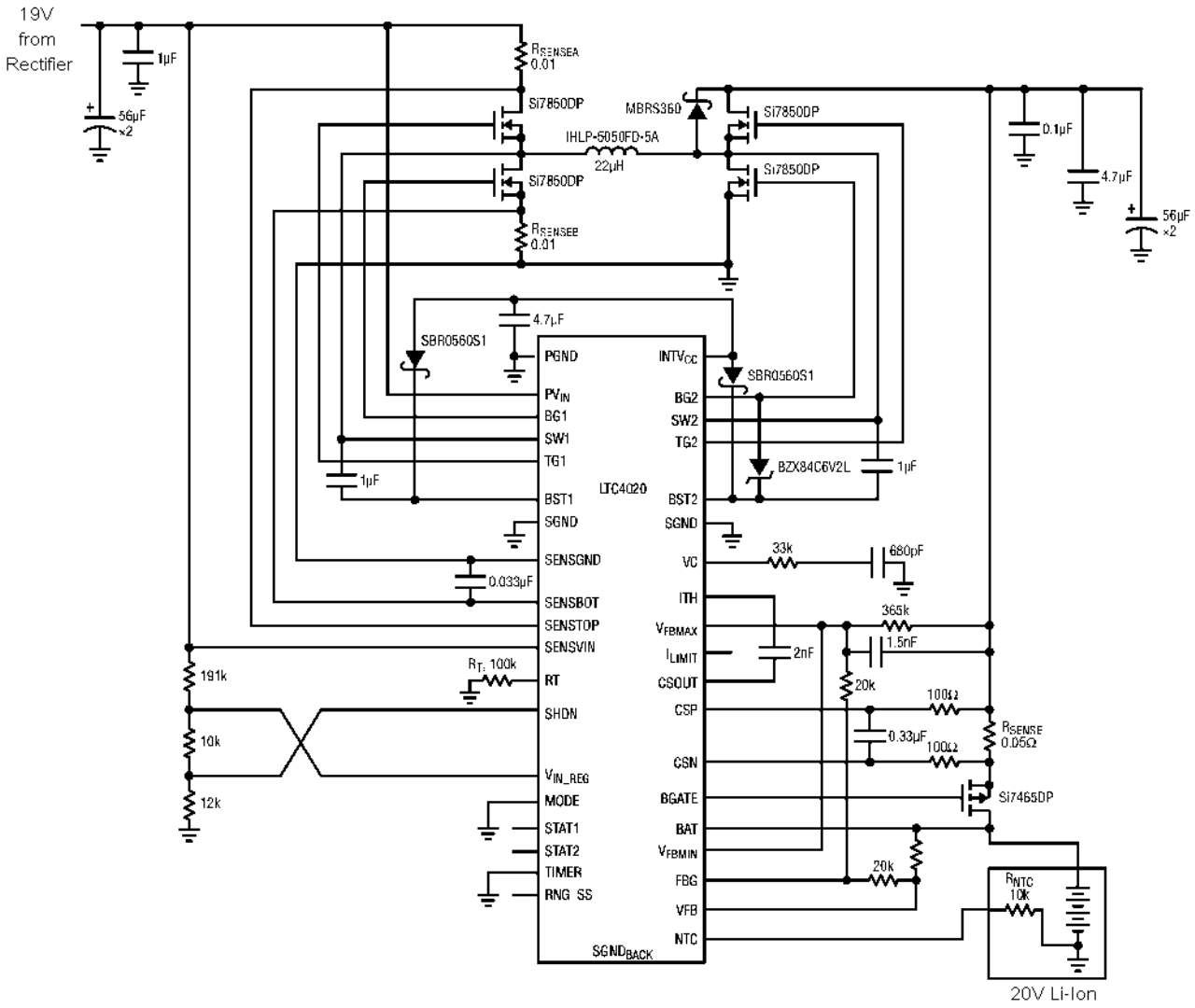


Figure 3

Conclusion

The *Open Dots*™ technology is the ideal match for wire-free power tool battery charging. The charging enablement is comprised of three blocks. An active rectifier is used to provide the unregulated voltage to the charger. A supervisory circuit implements a turn-on delay to affect a soft start. It also senses the pad voltage in order to throttle the charging current to 1/3 C (500mA). A highly integrated charge controller is employed as the third block. This solution optimizes charge time while ensuring battery safety.