Lonestar Microtape Cost Reduction

Suggested Plan

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SECTION 1

INTRODUCTION

1.1 DESCRIPTION

The LONESTAR MICROTAPE is a portable battery operated mass data or program storage device. It is designed to operate with the LONESTAR Advanced Language Calculator (ALC) or any device which supports the LONESTAR Inteligent Peripherals Bus structure, timing, and protocol.

Up to eight Microtapes are supported by the LONESTAR Intelligent Peripherals Bus (IPB) and each may have open or closed files at any one time. Each Microtape is designed to support a nominal data transfer rate of 8 Kilo baud in a reliable fashion with the Bus Master (nominally the ALC) Reading or Writing to a maximum of only one of the eight possible Microtape Devices at a time.

1.2 COST REDUCTION OBJECTIVES

The "Cost Reduction" is a normal part of the design cycle and should be considered at the earliest possible date. When the Microtape Peripheral was designed, the probability of a Cost Reduction was considered and some of the design was influenced by it. The objectives of the "Cost Reduction" are manifold and some of them are listed here:

*Must significantly reduce the total end product cost of the Microtape.

*Must make the end product easier to assemble.

*Must (should) make the Microtape significantly more reliable to operate and must be significantly more reliable electrically.

*Should be easier and require less manual labor to assemble.

*Should be much easier to implement the "build" cycle in a Robotic Assembly environment.

*Should, if possible, improve the total Microtape performance yet still be compatible with current devices.

SECTION 2

ELECTRICAL SECTION ANALYSIS

2.1 70C20 PROCESSOR SECTION

The 70C20 Processor Section sessentially consist of the processor, crystal timebase, switch and pullup logic. Important areas to examine here are:

done

*Replacement of the crystal with a ceramic resonator

defined *Obtaining a more inexpensive switch integrate it in

*Decreasing cost of the processor as a function of time.

2.2 INTELLIGENT PERIPHERALS BUS (IPB) INTERFACE SECTION

The IOBC Chip is currently integrated as a gate array with external pullup resistors. The obvious cost reduction is to implement the IOBC and the seven pullup resistors into a custom IC package. This would reduce cost and also allow the performance to be improved. Some things to consider in a custom package would include:

→[illegible] 7000 PC node integration 2.60(GA)→1.60(custom)→$1.0[illegible]

*Overvoltage and Undervoltage protection for the IPB Interface pins. Something similiar to the National Semiconductor MM914N might work well. It is protected from both over- voltages and undervoltages.

~~$.9[illegible]~~ for .85 7000 PC IOBC chip

*Improved sink capability for the Open Drain Drivers to improve bus "fall times".

All seven Pullups in Package - large Value for I[illegible].

*Utilize a high speed CMOS process to improve system margins and to reduce power consumption.

NOTE: If the seven pullup resistors are implemented on the custom IOBC Chip, then they must directly tie to the chip V+ line since they they may be used to provide initial charges to some peripherals. An internal zenier diode to limit internal V+ would also serve the chip well.

2.3 SENSORS SECTION

The Sensor Section has relatively few components when compared to

Sensors - cost Reduction

For the sensors, several things were Proposed.

1) - mechanical switches for WP position
- late to integrate & decision not to use

2.) electrical pins - switch to detect closure

Current - sensors are Honeywell / Fairchild
@ 1.05 each.

a source for a Plug also comptabile has been discovered & will be explored @ 0.75 each (.30 x 2 = .60 /drive)

Target -
Incorporate molded in sensors. Can get this for .28 a Sensor.. A Sensor here would be an emitter and a Photo detector.

Incorporate design statement from TI

the other sections. The two transistors, support resistors, voltage divider and two comparators should be integrated in with a Read/Write chip and in that section we discuss the integration more closely.

Of the two sensors, one resistor and one capacitor will remain.

2.4 READ/WRITE CIRCUITRY SECTION

The Read/Write Circuitry has great potential for cost reduction. At the present time, 5 ICs, 27 resistors, 7 diodes, 8 capacitors, and three transistors support both the Read/Write and the Sensor Circuit functions. These components may be replaced relatively easily by integration into a gate array or a semi-custom IC. An analysis follows below:

QTY.	COMPONENT REPLACED	COST EACH	COST TOTAL	IC EQUIV. TOTAL*	INSERTION COST
1	~~TL062N~~ TL082CN	~~$1.24~~ .42	~~$1.24~~ .42	0.4	$0.005
1	LM339N	~~.28~~ .20	.28 .20	.7	.005
1	CD4070B	.14	.14	.7	.005
1	74C240N 74C02	.79	.79	1.0	.005
~~1~~	~~COUNTER~~	~~.22~~ -.17	~~.35~~ .11	~~.8~~ .7	~~.005~~
7 ~~13~~	1% RESISTORS	.017	~~.221~~ .119	~~1.3~~ .7	~~.065~~ 0.035
20 ~~14~~	5% RESISTORS	.005	~~.07~~ .100	~~1.4~~ 2.0	~~.070~~ .100
~~7~~ 5	DIODES	.015	~~.105~~ .075	~~.7~~ .5	~~.035~~ .035
~~1~~	~~.1mF/.27 5%~~	~~.075~~	~~.075~~	~~1~~	~~.005~~
~~7~~ 1	.1mF, BYPASS	.045	~~.315~~ .045	~~.2~~ .1	~~.035~~ .005
~~3~~ 1	TRANSISTORS	~~.05~~ .067	~~.15~~ .067	~~.45~~ .15	~~.05~~ .030
--			-----	----	-----
~~52~~	TOTALS	20 second line	$3.736	8.15	$0.275

1.42 ~~1.82~~ 3.47

If we do a ~~18~~ pin semi-custom IC, then we can project a cost of around ~~$1.50~~ typical, ~~$1.80~~ maximum for the part (based on a discussion with Thurston Awalt of EXAR Corp. and Leo Manion of TMI (a sales rep. firm and our contact with EXAR)). ~~A typical integration fee could be considered around $20K (about twice what a similiar integration would cost => this is a conservative number). Thus for 100K pieces, we obtain an amoritized cost of $1.70 typical and $2.00 maximum.~~ The IC Equivalent Space is 0.9 units. We also expect a 75% (worst case) to 90% (best case) reduction in the amount of idle power to operate this section since Power CMOS is the desired process. (The reduced power consumption would typically yield an additional 1 to 2 hours of operation.)

15.5K → Semicustom

$20 more for Full custom

3.6 (for Semicustom)

Semicustom

1.56 for a Custom part

1 120pf .2475

2 10uF

33pf

1 .0022uF

1 .001uF

Klex film

Small Board (PC)

Londstaffe

1030 since 5/10/hr aa 20 sec line

The 18 pin device would have pinouts as shown below:

```
                          +---------------------+
Write Data----------->|1   Read/Wrtie     18|<----------POWER (+5V
                      |    Semicustom        |
Write Data Enable--->|2   Circuit*       17|<-----------EOT/BOT O
                      |                      |
Motor On/Off-------->|3                 16|<-------------WP Out (
                      |                      |
Raw Read Data<-------|4                 15|<--------EOT/BOT Out (
                      |                      |
Intr. 3<-------------|5                 14|<--------WP Sense In I
                      |                      |
WP Sense Out<--------|6                 13|<---EOT/BOT Sense in I
                      |                      |
WP On--------------->|7                 12|<-------Clock In (B7)
                      |                      |
EOT/BOT Sense Out<---|8                 11|<--------------->Spare
                      |                      |
GROUND ------------->|9                 10|<--------------->Spare
                          +---------------------+
```

*NOTE: Pinouts not final on this product

In terms of the difference between a semicustom IC and the multi-component equivalent, the following parameters are of interest:

	Multi-Component	Semicustom	
VALUES			
Part Cost	3.736	2.00 (max)	dollars
Insertion Cost	.275	.005	dollars
PC Board Cost	.58	.064	dollars
IC Equivalents	8.15	.90	IC-EQ
Power Consumption	2.12	.53 (max)	Ma
MERITS			
Reliability		+	
Assembly Ease		+	
Adaptable to RIU		+	
Insertion		+	
Spoilage		+	
Multi-Sourced	+		
COST			

Repair Testing

2.5 POWER SUPPLY SECTION

In the Power Supply Section, several things may be done to reduce cost and improve performance. Regulators At the present time, we have ~~three regulators,~~ two switching ~~and one linear)~~ in the circuit providing power. Together, the three devices yield a very high performance level from a wide variety of input voltages ~~and from a wide variety of input voltage sources.~~ The typical efficiency of 78% is considered quite good for a power supply. We may do several things to improve upon the 78% typical efficiency and still reduce our cost significantly. We include several proposed items here.

The present power supply is divided up into two sections: a +5V System Supply and a +4V Motor Supply (this supply may be turned off under software control).

2.5.1 +5V SYSTEM SUPPLY

The +5V System Supply has two components: a linear regulator and a switching regulator. When there is sufficient external voltage, the linear regulator provides power to the system. When the external voltage is insufficient, the switching regulator will provide power to the system if the batteries have fallen below 5.1V. In this intermediate time of insufficient external voltage and battery voltage greater than 5.1V, the batteries serve as the system supply through a germanium diode drop (typically .2V at our power level). This arrangement assures maximum efficiency at all times and allows the wide variety of input voltages.

When first designing the power supply, I initially looked for a high power Charge Pump. The Charge Pump would provide sufficient power for the system and do it in an extremely efficient (>95%) manner. I was unable to find a device that would allow widely varying input voltages, provide a 8 Ma to 20 Ma nominal power source, and be able to utilize external devices to increase power supply capability significantly all in one package at a reasonable cost. With a semicustom design, we may obtain all of the parameters required at a very reasonable cost. Some of these parameters include:

*Greater than 20 Ma of power (preferrably 35-50 Ma) at the voltage of interest. This voltage of interest may be between 2.8 and 10 Volts but is typically 5V.

*Must be able to accept a widely varying, two source input voltage from 1.1 to 20 Volts. We do not expect to be able to provide an output voltage independent of output load or input voltage, but we expect a fairly tolerent "plateau" of operating conditions.

*Must be very efficient and be very tolerant of load level transients. (These two parameters are usually an inherent characteristic of Charge Pumps.)

*Must be very inexpensive to produce and be able to work with external devices (boost transistors/VFETs, other charge pumps, external level shifting devices, etc.).

*Must be able to "trip" out of the system under excessive current loads, short circuits, and other fault conditions.

*Must be constructed in a Low Power process (preferrably CMOS) an be able to operate over a wide range of frequencies.

In a discussion later, we will analyze a method to achieve the above goals.

2.5.2 +4V Motor Supply

The +4V Motor Supply has two components, a switching regulator to provide the motor voltage and a voltage discriminator circuit. The Switching Regulator "bucks" a voltage down to 4.0V from a minimum voltage of 4.08V (typically). The voltage which the Switching regulator works on is selected by means of the voltage discriminator circuit. This circuit uses the voltage comparator inside of the RC4193 regulator to determine if the External Voltage (which ever voltage is the higher of IPB V(dd) or local DC Charger/Adapter) is sufficiently high (4.3V nominal) to power the Microtape. If the External Voltage is not high enough, then the Motor Circuit will use battery power. With a typical efficiency of 78% and a typical load of 25 Ma (35 Ma probable maximum), this circuit looks to be a prime candidate for a beefed up Charge Pump but, because the motor must turn on and of fairly fast (to minimize tape wastage), the Charge Pump is not a desireable power supply design. We could build a 35-55 Ma Charge Pump and use a transistor or (better yet) a VFET to turn the motor on and off, but this may not be as efficient. Our best choice is a high frequency DC-DC converter operating in either a "buck" configuration or with a miniature transformer. A desireable efficiency would be on the order of 85-95%. Some of the parameters of interest include:

*Must provide between 35 and 55 Ma of current in an efficient (between 85 and 95%), inexpensive manner.

*Must be able to accept a wide variety of input voltages ranging from 20V to 4.1V (if a "buck" configuration) or 3.2V (if a transformer configuration). The output should be 4.0V +/- 2% by design and will (with the motor in place) be 4.0V +/-5%.

*Must allow a "dual" input voltage and select the "External Voltage" when it is of sufficient voltage.

*Must allow the user to turn the Motor off when not in use and consume a very small current when off.

In the next subsection, we will discuss a method of obtaining the required performance and discuss the IC sectional components as well.

2.5.3 SEMICUSTOM POWER SUPPLY IC

There are many sections to a Semicustom Power Supply IC. Instead of "walking through" a design trace, we will present each section separately and then show how it would link together.

2.5.3.1 MICRO CHARGE PUMP SECTION

The function of the Micro Charge Pump is to provide internal power for the chip and to provide an external reference voltage for other system components. This will be particularly useful for situations using VFETs. The Micro Charge Pump is the first internal section to "come up" and it allows the IC to accept a wide variety of input voltages.

2.5.3.2 OSCILLATOR SECTION

Actually consisting of two separate sections (one for the charge pump and one for the switching regulator), the oscillators provide a reference frequency for the IC. The internal Micro Charge Pump does not require any additional components or logic to operate whereas the two Oscillators depend on an external capacitor to provide the control element. By being able to vary an external Capacitor, the system designer can optimize the efficiency of a particular system.

2.5.3.3 COMPARATOR SECTION

Consisting of several different comparators, this section does several things. It discriminates between the two external voltages and generates a signal (which can be system monitored) to control which voltage is used for each section. It also serves to generate a "Low Power" or "Low Battery" message. The actual reference levels are set by external divider networks.

2.5.3.4 SWITCHING REGULATOR SECTION

The Switching Regulator circuit is fairly simple. The comparator section provides a "greater than" or "less than" signal which is logically anded with the value form the comparator section. The resulting value is output to an external drive element (transistor or VFET) and may be pulled "very high" with a resistor to the Micro Charge Pump reference voltage for use with P Channel and N Channel VFETS.

2.5.3.5 MISC. CIRCUITRY SECTION

We may add additional internal circuitry to the Semicustom IC if pin number and Silicon Real Estate allow soas to make it more universal in the peripherals we offer.

2.6 SUMMARY

At this time, we envision the Microtape Power Supply Chip to be approximately 2/3 the cost of the current three chip regulator design. We also expect that the Power Supply power consumption will be much less than our current design. Overall, we expect that that the average circuit efficiency will increase by 8-15% thus yielding an additional total Motor On Time of 4 to 6 hours. Only building and testing a circuit fitting our specified topology yield an exact performance increase figure. Finally, we expect the Microtape Semicustom Power Supply IC to be used in a wide variety of peripherals, thus further reducing the cost.