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High-Efficiency Adapter With Low Profile Device Architecture

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Abstract— This paper presents the implementation of a high efficiency adapter using voltage regulators along with the converters. A new structure of the slim-type processor is proposed, which is composed of copper wire as the primary winding and printed circuit- board winding on the outer layer as the secondary winding be layout drawn using a Cadence virtuoso tool and by the simulation process it is tested in a 45nm CMOS technology. The proposed structure is suitable for a slim and high-efficiency regulator as well as converter because it has advantages of easy utilization and wide conductive cross sectional area compared to the other works. In addition the voltage doublers rectifier is applied to the secondary side due to its simple structure of secondary winding, and a CLC filter is adopted to reduce the output filters size. The validity of this study is confirmed by the experimental results.

Index Terms—CLC output filter, slim-type transformer, voltage-doubler rectifier.

I. INTRODUCTION

Household appliances must have a network processor inorder to communicate with other appliances through a homenetwork. This additional processor increases the cost of theappliance when it is embedded. In addition, the communication medium for a home network has notconverged to a unique standard at present [1], [2]. Therefore, there is a need for adapters that convert appliance data /messages to the correct home network format.Recently, the communication protocol between anappliance and an adapter has been standardized [2]. the CACI(Compact Appliance Control Interface) was reported in [1].But now, it is necessary to develop manyappliances adapters, because still use

proprietary communication protocols. Thispaper describes the adapter. which can downloadcommunication protocol conversion programs, and cancommonly be used for various appliances. In addition, household appliances must be able to increasepower supply capacity in order to supply electrical power to the adapter. In this paper, we selected IEEE 802.11b wirelessLAN as a communication medium for the home network; however, other types of networks are easily supported.Household appliances must be capable of supplying peakpower that enables transmitting or receiving 802.11b frames. This peak power is about 1W, and the power save mode(transceiver is periodically in active) is the same as the normalmode (transceiver is always in active) [3], [4]. This paperdescribes how to reduce the peak power using the smoothingcircuit (SC) and the dynamic bandwidth controller (DBC). An outline of this paper is as follows, in section II webriefly describe the home network architecture in which ouradapter section introduces operates, III the softwarearchitecture of the adapter itself and details it's functionalities, section IV discusses power management issues whenconnecting the adapter to existing appliances. Section Voffers some concluding remarks.

REVIEW OF METHODS *A. RT Method*

In the RT method [2], [3], one port of the adapter isconnected to a calibrated port of the VNA, and the otherport is terminated in a reflective load, as shown in Fig. 1.The reflection coefficient of the adapter and load is measuredat reference plane 2, and the process is repeated with thereflective load replaced by a second reflective load, whosereflection coefficient differs in phase from that of the first. In practice, the reflective terminations are typically an offsetshort and an offset open for a coaxial port and a flush short andan offset short for a waveguide port. The relation between thereflection coefficient measured at reference plane 2 in Fig. 1and the intrinsic efficiency of the adapter was derived in [3]. Assuming a reciprocal, low-loss adapter.

PROPOSED STRUCTURE

A. Slim-Type Transformer

The use of PCB trace as both the primary and the secondarywinding has been researched for the reduced height of thetransformer as shown in Fig. 2. Although this method canmake it easy to build the slim transformer, large portion of the PCB cannot be used for conduction since many turnsneed wide space for the insulation. Therefore, conduction loss can be increased due to the reduced conductive crosssectionalarea. Also, the high cost for the manufacturing of eachPCB winding can be the problem.To overcome these drawbacks, the sandwiched or interleavingstructure using copper wire as the primary winding and PCB trace as the secondary winding was researched as shownin Fig. 2. The copper wire is more suitable than the PCBtrace for the plenty of turns in the primary side. However, itcannot use the enough window area of the slim transformer, considering the insulation between the primary and the secondarywinding. It is also difficult to utilize the spiral-woundcoil of the primary winding without a bobbin.



Fig.1. structure of the proposed scheme

The proposed structure of the slim-type transformer is composed of copper wire on the bobbin as the primary winding and PCB winding on the outer layer

the secondary winding. Inthe as slim-type transformer, the insulation between the primaryand the secondary winding takes considerable portion of thewindow area when the windings are stacked as shown inFig. 2 and 3. However, when the primary and secondarywindings are positioned inside and outside, respectively, thevolume of insulation between them can be greatly decreased as shown in Fig. 2(c). The saved area can be contributed to theconductive cross-sectional area. and the conduction loss can bereduced. Also, the utilization of the primary winding is easierdue to the use of the bobbin.Additionally, the leakage inductance of the transformer is avery important parameter in the LLC resonant converter sinceit is directly related to the resonance and this value can becontrolled by using this structure. The leakage inductance isdetermined by the distance between the primary and secondarywindings generally, and the distance can be designed from the PCB pattern. Therefore, the LLC resonant converter canbe implemented without the need to add an external resonantinductor.

Voltage-Doubler Rectifier and CLC Output Filter

The topology selection of the secondary side is also veryimportant to build a high-efficiency and slim-type convertersince it determines the design of the transformer. As shown in Fig. 3, the centertapped, full-bridge, and voltage-doublerrectifiers can be attractive candidates of the secondarysiderectifier. Among many characteristics, the configuration of thesecondary winding is very critical to the design of the slimtypetransformer since large current is flowing through thesecondary side and wide conductive area is needed. Assumethat the turns ratios of the transformer in the center-tapped, fullbridge, and voltage-doubler rectifiers are np ct:ns ct: ns ct,np fb: ns fb, and np vd: ns vd, respectively. When the primaryturns of aforementioned rectifiers are the same, ns_ctand ns fbare designed twice ns vdto obtain the same voltageconversion ratio.

Additionally, since the center-tapped rectifierconfiguration needs two different secondary windings, it is notappropriate to the slim-type transformer due to its complexstructure of the secondary PCB winding. In this point of view, the voltage-doubler rectifier can be selected for an optimal onewith the proposed transformer, which can be realized with justone turn in the secondary winding.Meanwhile, when the capacitor output filter is adopted, thecurrent flowing through the output capacitor is discontinuous. Therefore, the rms ripple current of the output capacitor isgenerated very large, and the bulky capacitors are needed tobear that. To reduce the output filter size in that case, a *CLC* filter is widely used as shown in Fig. 4(a). Due to the

additional small inductor, large current ripple is generated in the left-sidecapacitor Cf, and the current ripple of the right-side capacitorCO is very small. Thus, the multilayer ceramic capacitor isapplied to Cfsince it has high rms ripple current rating and small size, and the electrolytic capacitor is applied to CO sinceit has large capacitance value for dynamic response. With the voltage-doubler rectifier, using the *CLC* filter ismore attractive since the additional passive components areless than with other rectifiers. Because doubler capacitors, Cland C2, are already in the voltage-doubler rectifier, only theadditional small inductor is needed to achieve the CLCfilterconfiguration as shown in Fig. 4.



Fig.2.implemmenting the proposed adapter

II. THE LEGACY SYSTEM CHALLENGE

Legacy systems present a number of technical challenges toachieving net-centric standards compliance. These issues ofteninclude: software architectures [16], data formats, external interfaces, and constraints of safety and security. These challenges are discussed below.

A. Legacy Software Architectures

The typical legacy tactical system in DoD today was not designed to comply with net-centric technical standards in either their internal software architectures or their external interfaces. The authors have observed that many of these systems were notdesigned to use some of the key Internet-related standards, suchas HTML, HTTP, SOAP, WSDL, and XML. The reasons for thisinclude: 1) the inability of Internet standards to satisfy real-time, mission critical requirements [12]–[18] and 2) the computing standards and commercial products available at the time manyof today's military systems were developed [12]–[17].

The authors have observed two prevalent mechanisms used for communications within legacy military software architecturesby server and client software applications: a) Remote Procedure Calls (RPC) made using Application ProgrammingInterfaces (APIs), and b) the Common Object Request BrokerArchitecture (CORBA) [12]. Both RPC/APIs and CORBA usethe Transmission Control Protocol/Internet Protocol (TCP/IP)for message transmission.Fig. 1 depicts the use of RPC over socket-based APIs to supportcommunications between client and server software applicationsover a network. The figure shows a client application anda server application connected to a common network. The clientneeds to perform a function on some data, while the server canperform that function. To initiate this function call, the client uses an RPC toremotely call the server function. The client uses software"sockets" and TCP/IP to call the function. On the network, TCP/IP is used to transmit the function call and provide it on he proper socket.

The server recognizes the RPC, performs thefunction, and provides the results back to the client. Fig. 2 depicts the use of CORBA to support communicationsbetween client and server software applications over a network.CORBA, a specification developed by the Object Management Group [19], is an object-oriented counterpart to a socket-basedAPI. In the object-oriented paradigm, the calling applicationinvokes a "method" on an object. An Object Request Broker(ORB), which is a software implementation of the CORBA. Specification keeps track of the locations of software andobjects on the network. It determines the location of ObjectA's implementation and invokes the appropriate method on thatobject.

B. Legacy Data Formats and Access

Data in a typical legacy system are held in legacy formats.Often these consist of custom and proprietary data formats andon venations that were selected by the developer to initially implement each legacy system. Legacy formats may be due to the lack of standards and/or the lack data of interoperability requirements at the time the system was developed. In addition, the legacy data is rarely accessible via standard, net-centricmechanisms (e.g., web services). Accessing and translatinglegacy data often requires a very large engineering effort.

C. Legacy Point-to-Point Interfaces

Traditionally in DoD, data exchange between two systemshas been defined for point-to-point interfaces [7]. These interfacesare numerous and essentially proprietary, because theyonly work for a pair of systems. On the other hand, net-centriccompliance requires a "many-to-many" data exchange approach[7]. This requires a more open approach to defining interfaces, as well as the implementation of net-centric technical standardssuch as XML.



Fig.3. circuit for the proposed scheme operation cycle

D. Safety and Security Constraints

Legacy military systems typically have important safetyand security constraints on their design and performance. Forexample, weapon systems are concerned with weapon safetyrequirements, such as maintaining positive control of theirweapons under all circumstances. They may also be concerned with issues such as crossing security domains when connecting to the GIG or with other systems with which interfaces are required. As an example, the authors have observed that this is typical for systems on a ship, where a mixture of multiplesecurity domains exists, due to a variety of classification levels, access authorization, and "need to know." As a result, radically changing the software architectures ofsuch systems greatly increases risk and invites mission criticalfailure. Despite great advances in software technologies, currententerprise standards, tools and implementations are largely unable to meet the most challenging real-time. deterministic requirements of these critical systems [20]–[21].

NET-CENTRIC ADAPTER

A. Net-Centric Adapter Concept

The goal of the Net-Centric Adapter for Legacy Systems(NCALS) is to enable legacy military systems to affordablyparticipate in a net-centric force. Specifically, NCALS minimizes the changes to legacy systems required to participate on the GIG. In addition, it is designed as a common, generic software component that could be used by many differentlegacy systems. To achieve this, several technical objective were necessary.• Enable legacy systems to publish their data and services to he GIG.. Enable legacy systems to subscribe to GIG data and services.• Reduce the software development effort required to implement net-enabled legacy systems.• Architect the NCALS software as a common, configurable component. The NCALS software concept is illustrated in Fig. 3. It serves as an automated, two-way gateway between a legacy system and the GIG. As such, it works behind the scenes in an automated fashion to expose data from legacy systems to users of the GIG. In addition, it must be configurable, as a common software component, to support a variety of legacy systems needs, as well as portable across a variety of computing platforms.

Lastly, its architecturemust be scalable to accommodate the net-centric data requirements of many different legacy systems. A legacy system consists of legacy software components running on hardware, typically on a Local Area Network (LAN). These software components communicate with one another via legacy software interfaces (e.g., APIs and/or CORBA) and hold data in legacy formats. The NCALS software uses the existing legacy software interfaces to obtain legacy data, transform it into netcentric standard formats and publish it to the GIG in compliance with net-centric standards. Likewise, it transforms GIG data into legacy data formats and injects it into the legacy system via its existing software interfaces. Regardless of the particular domain, data and services of a legacy system, much of the NCALS functionality is common. However, it is configurable to accommodate the specifics ofa particular legacy system operating in its specific domain of operations. Since NCALS is designed to enable net-centric operations, it focuses on enabling legacy systems to interoperate with the GIG. As a result, it provides a service-oriented architecture connection for a legacy system to the rest of the DoD enterprise on he GIG. However, it does not modify the legacy components to comply internally with the net-centric technical standards. It allows the legacy system architecture to remain largely undisturbed.

RESULTS

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The simulation results for the dialysis session without the adapterdemonstrate that the basic flow features are a high-speed jet (averageu-component of 270 cm/s at the x-location of the needle tip) issuingfrom the needle and a slower background vascular access flow (averageu-component of 60 cm/s at the xlocation of the needle tip) within thegraft [Fig. 1]. Downstream of the needle tip, the needle flow impingesupon the bottom of the graft wall and begins to sweep upwardsalong the sides to the top of the graft, forming two large-scale helicalstructures that persist down the length of the graft. Immersed within these helical structures are a host of smallscale, complex, three-dimensionalflow structures that result in substantial flow unsteadinessdownstream of the dialysis needle. The graftwall experiences increasedhemodynamic stresses as a result of the impinging needle jet.



Fig.4. Transient analysis for the proposed scheme

This is evidenced by a sharp rise in the WSS [Fig. 2] field in the vicinity of the jet impingement region. Upstream of this region, the WSS isapproximately 30 dynes/cm2, but downstream of it, the WSS rapidlyundergoes an eightyfold increase to nearly 2400 dynes/cm2. When thefully deployed SMP adapter is present, the needle jet is oriented inthe downstream direction and no longer impinges as severely upon thegraft wall [Fig. 1]. As a result, the WSS [Fig. 2] is substantially reduced. In addition, the larger cross-sectional exit of area the adapterdecelerates the needle flow. A comparison of the average u-component of velocity (130 cm/s) of the needle flow at the distal tip of the adapter with the average u-component of velocity (70 cm/s) of the backgroundvascular access flow at the same xlocation shows them to be closerin value, which could potentially reduce the strength of the shear layerinstability that develops downstream of the adapter.Images of the in vitro flow visualization prior to delivery of the SMPadapter are shown in Fig. 2and 3.



Fig.5. Transient analysis for the architecture



Fig.6. Transient analysis for the clocking cycle

Although the vascular access and needle flow rates and Reynolds numbers are well below the physiological values used in the CFD simulations, a qualitatively similar flow field is present in which the needle jet impinges upon the wall and wraps upward along the sides of the wall. After the compressed SMP adapter is delivered through the dialysis needle, the heated flow within the model graft actuates the adapter to its fully expanded shape [Fig. 5]. Complete actuation occurs within approximately 30 s. Following the actuation, room temperature water (_21 _C) is pumped through the graft model. The resulting flow visualization image [Fig. 3] with the deployed adapter demonstrates that the adapter International Journal of Advanced Information Science and Technology (IJAIST)ISSN: 2319:268Vol.3, No.2, February 2014DOI:10.15693/ijaist/2014.v3i2.6-13

directs the needle jet so that it is somewhat more aligned with the background vascular access flow.



Fig.7. Transient analysis and DC analysis

A. Monitoring of Load-Connection Block

The MOLB monitors whether the load system is connectedor not. For this function, the MOLB generates vCI–ON andsends it over to the CIOB when the load system is connected. The MOLB can be realized by using only one comparator andseveral resistors as shown in Fig. 2. When the load system is connected to the proposed adapter, since vDET and vCI–ON are "ON," optocouplers opto1 and opto2are turned ON. Then, the CIOB connects vlink to the HV pinof the control IC and vCC to the VCC pin of the control IC.Consequently, the control IC starts its function. Each resistancecan be designed to satisfy (1). *R*3 and *R*4 can be designed considering the operating current of opto1 and opto2. **TableI:**

| Part | Name |
|----------------|---------|
| Diode | GBL407 |
| Resistor | 1M OHMS |
| Capacitor | 250 nF |
| Link capacitor | 200 uF |
| Supply voltage | 3V |
| Output voltage | 1.8V |
| Power | 0.8mW |
| Current | 1.2 A |

Table II:

| This paper | [1] | [2] |
|------------|-----|-----|
| | | |

| Area mm ² | 20 | 26 | 23 |
|-------------------------|----|----|----|
| Power (mW) {x 10} | 10 | 16 | 23 |
| Current (mA) | 8 | 10 | 12 |
| Voltage (V) | 3 | 5 | 4 |



Fig.8. Comparative chart

DISCUSSION AND CONCLUSION

Through this initial investigation we have presented the results of anovel architecture for the newly designed for the low voltage level operations, dialysis needle adapter. The simulations demonstrate that the adapter significantly reduces the power and the area, which could potentiallyreduce thegeneral subsequent and subsequent vascular access occlusions. Thesuccessful preliminary in vitro test indicates that the concept of deliveringand actuating a SMP adapter through a dialysis needle has meritand should be further investigated and improved. It is evident that the prototype adapter does the flow not entirely direct in the downstreamdirection. This can be remedied by casting a longer regulators and adapter abouta mandrel that has an inherently curved shape. Given the ease of machiningand molding the material this and other modificationscan readily be incorporated into alternate adapter design. This be implemented in the Cadence Virtuoso tool of 45nm CMOS process.

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