TS-ENC730
Enclosure Manual

Technologic
SYSTEMS

Feedback and Update to this Manual

To help our customers make the most of our products, we are continually making additional and updated resources available on the **Technologic Systems website** (www.embeddedARM.com).

These include manuals, application notes, programming examples, and updated software and firmware. Check in periodically to see what's new!

When we are prioritizing work on these updated resources, feedback from customers (and prospective customers) is the number one influence. If you have questions, comments, or concerns about your Embedded Computer, please let us know at **support@embeddedARM.com**.

Limited Warranty

Technologic Systems warrants this product to be free of defects in material and workmanship for a period of one year from date of purchase.

During this warranty period Technologic Systems will repair or replace the defective unit in accordance with the following process:

A copy of the original invoice must be included when returning the defective unit to Technologic Systems, Inc.

This limited warranty does not cover damages resulting from lightning or other power surges, misuse, abuse, abnormal conditions of operation, or attempts to alter or modify the function of the product.

This warranty is limited to the repair or replacement of the defective unit. In no event shall Technologic Systems be liable or responsible for any loss or damages, including but not limited to any lost profits, incidental or consequential damages, loss of business, or anticipatory profits arising from the use or inability to use this product.

Repairs made after the expiration of the warranty period are subject to a repair charge and the cost of return shipping. Please, contact Technologic Systems to arrange for any repair service and to obtain repair charge information.

FCC Advisory Statement

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used properly (that is, in strict accordance with the manufacturer's instructions), may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the owner will be required to correct the interference at his own expense.

If this equipment does cause interference, which can be determined by turning the unit on and off, the user is encouraged to try the following measures to correct the interference:

•   Reorient the receiving antenna.
•   Relocate the unit with respect to the receiver.
•   Plug the unit into a different outlet so that the unit and receiver are on different branch circuits.
•   Ensure that mounting screws and connector attachment screws are tightly secured.
•   Ensure that good quality, shielded, and grounded cables are used for all data communications.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The following booklets prepared by the Federal Communications Commission (FCC) may also prove helpful:

•   How to Identify and Resolve Radio-TV Interference Problems (Stock No. 004-000-000345-4)
•   Interface Handbook (Stock No. 004-000-004505-7)

These booklets may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

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1 PRODUCT OVERVIEW

1.1 Introduction

The TS-ENC730 metal enclosure is made to house the TS-7300 Single Board Computer and up to two PC/104 peripheral boards. The internal power regulator efficiently converts unregulated 7-28 VDC input into regulated +5 VDC as required by the SBC. Sleep mode allows current drain of 200 microAmps with programmable sleep periods.

The TS-ENC730 also brings out some features implemented on the TS-7300 FPGA, such as the SJA1000 CAN core, PWM for the DAC lines, 800x600 VGA Video, second ethernet port, additional serial ports, etc.

In addition, the TS-ENC730 includes the TS-732 daughter board for the TS-7300 onboard FPGA. The AVR microcontroller on the TS-732 implements ADC/GPIO/LEDs extra functionalities. Also, the physical layer for the CAN bus is provided by the TS-732.

1.2 Features and Benefits

The TS-ENC730 Rugged Enclosure provides extra functions, including power converter, AVR microcontroller daughter board and CAN Phy. Additional features include:

✔ 8-28 VDC power input

✔ User programmable low power sleep mode (300 uA)

✔ Surge suppression on power input

✔ Terminal strip with 8 I/O

> ✔ 4 channel 10 bit ADC 0V - 5V (12-16 bits effective*)
>
> ✔ 2 channel 12 bit high power DAC 0V - 10V (sync/source 300mA)

✔ 4 high current GPIO pins (sync/source 400 mA)

✔ 5-8 COM ports

✔ Two software controlled LEDs

✔ Status LEDs for both Ethernet ports

✔ Optional CAN bus port with Linux driver available

✔ Linux Application available for ADC/DAC/GPIO/LEDs control

✔ Sturdy metal design reduces noise

1.3 Related Products

The TS-ENC730 enclosure was designed to house the TS-7300 SBC along with all its features, including SD Card, VGA, User-Programmable FPGA, dual-ethernet, USB, and up to 2 PC/104 expansion boards, etc.

For further information on the TS-7300 Linux FPGA Computer, please refer to the TS-7300 documentation or web page.

1.4 Software and Support

✔ Free system software and documentation updates available on our web site

✔ Free technical support by phone, fax, or email

✔ 30-day, money back guarantee on evaluation units

✔ One-year, full warranty

2 GETTING STARTED

2.1 Handling the Board Safely

Before performing any set up or placement procedures, take the precautions outlined in this section.

✔ Be sure to take appropriate Electrostatic Discharge (ESD) precautions.

✔ Disconnect the power cable at the rear panel of the enclosure before moving, cabling, or performing any set up procedures

> **!** **Warning**
> Inappropriate handling may cause damage to the board inside the enclosure.

2.2 Setup and Installation Instructions

Follow these guidelines for safety and maximum product performance:

✔ Observe local health and safety requirements and guidelines for manual material handling.

✔ Set the enclosure on a level surface with adequate ventilation.

✔ Ensure the rubber feet are used for protection and stability on level surfaces.

✔ Wall-mount the unit if placement on a level surface is not available, or desired.

2.3 Setup Tools

Depending on placement and cabling of the enclosure, you may need the following tools:

✔ Small flat-blade screwdriver

✔ Small Phillips screwdriver

2.4 Setup Procedure

After locating, setting up, grounding, and cabling the enclosure:

✔ Apply power to the unit (refer to the "10-pin Terminal Strip" section)

✔ Monitor COM1 using a terminal emulator to verify that the enclosure is operating properly.

2.5 Disconnecting AC Power

✔ Unplug the power cord from the power source.

✔ Disconnect the power cord from the rear panel of the enclosure.

3 COMPONENTS

3.1 TS-7300 FPGA CORE FOR TS-ENC730: REGISTER MAP

The TS-ENC730 includes a TS-7300 FPGA core designed specially for the TS-ENC730 and the TS-732 daughter companion board. This FPGA core talks to the AVR Microcontroller on the TS-732 via a UART interface, making use of the 8x baud clock reference provided by the AVR. This FPGA core also implements a SJA1000 CAN controller and 2 PWM channels for the TS-732 DAC circuitry. The registers that control these functions appear in the memory space of the ARM9 processor dedicated for the FPGA functions, therefore they can be accessed through the Linux OS and programming. The base address used is **0x7200_0400** and the register are **16-bit** wide. The following is the register map for the TS-ENC730/TS-732:

Table: Register map for TS-ENC730/TS-732 control

| I/O Addr	Description	Data Bits and such
BASE + 0	Control register	bits 3:15 – reserved bit 2: CAN controller enable bit 1: PWM channel #1 enable bit 0: PWM channel #0 enable
BASE + 2	PWM channel #0 high-time	
BASE + 4	PWM channel #0 low-time	
BASE + 6	PWM channel #1 high-time	
BASE + 8	PWM channel #1 low-time	
BASE + A	AVR clock reference	
BASE + C	AVR UART STAT register	
BASE + E	AVR UART RXDAT/TXDAT register	
BASE + 100	CAN controller regs start	SJA1000: 256 byte x 8bit registers

Note
The AVR clock reference represents the current frequency/2 of the clock coming out the AVR. Nominally this should be 100Khz. Register value is updated twice per second.

3.2 Front and Rear Panels

The TS-ENC730 front panel is shown on the first page of this manual.
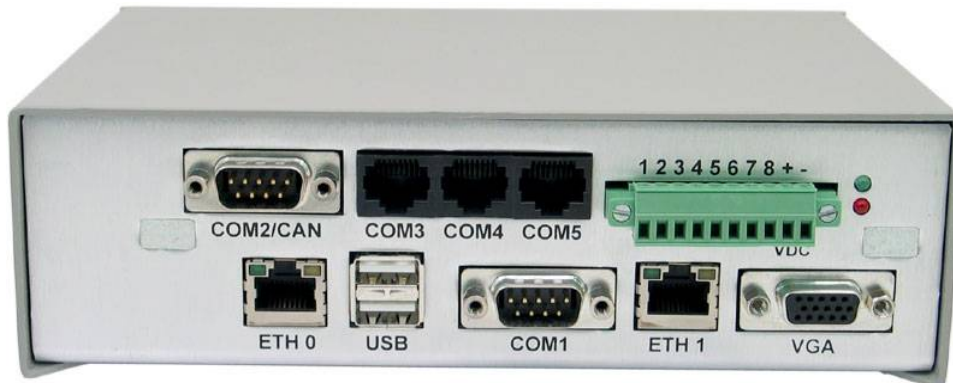
TS-ENC730 Rear Panel Connectors

The rear panel of the TS-ENC730 enclosure (shown above) has all the input/output connectors, including four COM ports, one CAN port shared with another COM port, one VGA port, two ethernet ports, two USB ports and one 10-pin terminal strip. Also, it includes two LEDs, red and green.

3.3 Standard Headers and Connectors

COM1: Console RS-232 Serial Port

The COM1 RS-232 port uses a standard DB-9 male connector on the **TS-ENC730**.

Table: COM1 DB9 Pin-Outs

DB9 Pin	Signal	Description
1	DCD	Data Carrier Detect
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request to Send
8	CTS	Clear to Send
9	--	--

Note
The COM1 port on the TS-ENC730 is the default port used for system console. The RC-DB9 cable must be connected to the COM1 in order to have a Linux console via any terminal emulator.

USB

The USB Connector on the **TS-ENC730** provide two USB interfaces for the user. These are directly connected to the EP9302 processor, which integrates an USB dual-port Open Host Controller Interface (Open HCI), providing full-speed serial communications ports at a baud rate of 12 Mbits/sec. Up to 127 USB devices (printer, mouse, camera, keyboard, etc.) and USB hubs can be connected to the USB host in the USB "tiered-star" topology.

ETH0 and ETH1

The ethernet connectors ETH0 and ETH1 makes use of a standard RJ-45 socket. They can be used to connect a standard 10/100 Ethernet cable into the enclosed SBC.

The ETH0 port is controlled by the ARM9 CPU, while the ETH1 port is controlled by the TS-7300 onboard FPGA.

> **Note**
> The right side LED above the Ethernet port indicates a 100-Mbit link, while the left side LED indicates network activity.

VGA

A standard DB15 VGA connector is available on the **TS-ENC730** for video interface. For further information on the VGA Video function, refer to the TS-7300 manual.

COM2/CAN

When the CAN jumpers are OFF, the COM2/CAN DB9 connector is connected straight to the COM2 header on the TS-7300, enabling communication to the second serial port on the ARM9 processor. For further information on this, please refer to the TS-7300 manual.

If the CAN jumpers are ON, then the COM2/CAN DB9 connectors brings out the CAN Bus signals. Technologic Systems provides a Linux Driver for our CAN core (Lincan Driver), which is a SJA1000. Please, refer to the TS-CAN1 manual for further information on how to use the Lincan Driver with the TS-T32/TS-ENC730.

> **Note**
> Please notice that the CAN Bus will only work if the CAN option was ordered for the TS-ENC730 enclosure, since the CAN PHY chip is optional for this product.

The RS-232 port brought out through the COM2 DB9 connector on the TS-ENC730 corresponds to the COM2 1-pin header of the TS-7300. It is also RS-485 full/half duplex capable, if the RS-485 option was ordered.

The general pin-out for the COM2/CAN DB9 connector is shown below:

Table: COM2/CAN Pin-Out Configuration

COM2 Header	DB9 Connector	RS-232	Half Duplex RS-485	Full Duplex RS-485	CAN
1	1		TX+ / RX+	TX+	
2	2	RXD			CANL
3	3	TXD			
4	7			RX+	CANH
5	5	GND	GND	GND	
6	6		TX- / RX-	TX-	
7	7				
8	8				
9	9			RX-	
10	-	-	-	-	

> **Note**
> The SJA1000 CAN controller on the TS-7300 FPGA run at 25Mhz, which might create problems when talking to other CAN devices clocked at standard 16Mhz or 24Mhz. Technologic Systems recommends 100Kbaud, 500Kbaud or 900Kbaud to be used with the TS-732 and the Lincan Driver. The 1042Kbaud can be used to set up a fast CAN network among TS-7300/TS-ENC730 devices only.

COM3, COM4, COM5

Standard RJ-45 sockets are used to bring out the additional COM ports, which are implemented on the TS-7300 FPGA. The RJ-45 connectors are connected straight to the FPGA COM headers (COM3, COM4, COM5) on the TS-7300. For further information on these, please refer to the TS-7300 manual.

The general RJ45 pin-out used for the TS-ENC730 follows:

Table: RJ-45 Pin-Out for COM ports

RJ45 Pin	Signal	Description
1	RING	Not Connected
2	DCD	Not Connected
3	DTR	Data Terminal Ready
4	GND	Ground
5	RXD	Receive Data
6	TXD	Transmit Data
7	CTS	Clear to Send
8	RTS	Request to Send

10-PIN Terminal Strip

The 10-PIN Terminal Strip on the TS-ENC730 is used for Power Source Input and data acquisition general functions such as A/D, D/A and GPDIO. The following table shows the Pin-Out for this connector:

Table: RJ-45 Pin-Out for COM ports

Terminal	Signal	Description
TERM1	DAC/ADC #1	D/A Converter #1 or A/D Converter #1
TERM2	DAC/ADC #2	D/A Converter #2 or A/D Converter #2
TERM3	ADC #3	A/D Converter #3
TERM4	ADC #4	A/D Converter #4
TERM5	GPDIO #1	Digital Input #1 or Digital Output #1
TERM6	GPDIO #2	Digital Input #2 or Digital Output #2 or Ground (if jumper GND6 ON)
TERM7	GPDIO #3	Digital Input #3 or Digital Output #3
TERM8	GPDIO #4	Digital Input #4 or Digital Output #4
TERM9	VCC	External 8-28VDC Power Input
TERM10	Ground	External Ground

> **Note**
> The PWM channel high/low counters run at 75Mhz

> **Note**
> The threshold on the Digital Input 2,3 and 4 is 2-2.2V, while it is about 0.4V on the Digital Input #1. The Digital Input #1 can be used to wake up the AVR microcontroller by connecting it to Ground.

Technologic Systems provides a Linux user-space application that handles all the PIN1 to PIN8 functions. This program talks to the AVR Microcontroller via an UART interface and can be used for AVR configuration as well as ADC, DAC and LEDs functionality. Contact Technologic Systems for more information on the Linux software package for the TS-732 AVR. Find below the help message of this command, named "ts732":

```
$ ts732 –help

Usage options:
  --dac1 [0|1]          disable or enable DAC1
  --dac2 [0|1]          disable or enable DAC2
  --led1 [0|1]          turn off or on the bottom LED
  --led2 [0|1]          turn off or on the top LED
  --dir5 [I|O]          set pin 5 to an Input or Output
  --dir6 [I|O]          set pin 6 to an Input or Output
  --dir7 [I|O]          set pin 7 to an Input or Output
  --dir8 [I|O]          set pin 8 to an Input or Output
  --data5 [0|1]         set pin 5 output to low or high
  --data6 [0|1]         set pin 6 output to low or high
  --data7 [0|1]         set pin 7 output to low or high
  --data8 [0|1]         set pin 8 output to low or high
  --filter1 <n>         set ADC 1 smoothing filter to 2^n (n in 0..15)
  --filter2 <n>         set ADC 2 smoothing filter to 2^n (n in 0..15)
  --filter3 <n>         set ADC 3 smoothing filter to 2^n (n in 0..15)
  --filter6 <n>         set ADC 6 smoothing filter to 2^n (n in 0..15)
  --filter4 <n>         set ADC 4 smoothing filter to 2^n (n in 0..15)
  --sleep <n>           sleep n seconds (n in 1..65535)
  --calibrate-time <n>  calibrate time in n seconds (3000 <= n <= 65535)
  --calibrate-adc <n>   calibrate ADC n (*)
  --calibrate-dac <n>   calibrate DAC n (*)
  --v1 <n>              set DAC1 output to the specific decimal voltage
  --v2 <n>              set DAC2 output to the specific decimal voltage
  --watch <n>           skip n-1 messages from AVR, then print current state
  --eer <adrs>          display 30 bytes of AVR EEPROM contents, starting at n
  --eeval <val>         set the value to write to the EEPROM (testing only)
  --eew <adrs>          write value to given AVR EEPROM adrs (testing only)
  --calibrate-time      perform an more accurate time calibration this run
  --help                get this help message
```

For example, in order to set 6V on the output of the DAC1, one can use the following command sequence:

```
$ ts732 --dac1 1
$ ts732 --v1 6
```

> **Note**
> Make sure the serial driver for the TS-732 is loaded on the TS-Kernel prior to use the "ts732" command.

3.4 TS-732 FPGA Daughter Board

The TS-732 FPGA daughter board should be connected to the TS-7300 40-pin header in order interface with the TS-7300 FPGA. The TS-732 implements a switching power supply in order to provide regulated power to the TS-7300 from a 8-28VDC external power source connected to the TS-ENC730 enclosure. In addition, the TS-732 includes a 8-bit AVR Microcontroller (Atmel ATMEGA48V) in order to implement the DAC and ADC functions that are available through the 10-pin terminal strip on the TS-ENC730.

TS-732 20-PIN Header

Table: TS-732 20-PIN Header Pin-Out

CANL	TER1	TER3	TER5	TER7	3.3V	RLED	GLED	N/C	+N/C
2	4	6	8	10	12	14	16	18	20
1*	3	5	7	9	11	13	15	17	19
CANH	GND	TER2	TER4	TER6	TER8	GND	VCC	VCC	VCC

Table: RJ-45 Pin-Out for COM ports

Pin	Signal	Description
1	CANH	GOES TO CAN DB9-PIN7
2	CANL	GOES TO CAN DB9-PIN2
3	GND	INPUT GND -> COMES FROM TERM10 OF THE 10-PIN TERMINAL STRIP
4	TERM1	TERM1 ON 10-PIN TERMINAL STRIP
5	TERM2	TERM2 ON 10-PIN TERMINAL STRIP
6	TERM3	TERM3 ON 10-PIN TERMINAL STRIP
7	TERM4	TERM4 ON 10-PIN TERMINAL STRIP
8	TERM5	TERM5 ON 10-PIN TERMINAL STRIP
9	TERM6	TERM6 ON 10-PIN TERMINAL STRIP
10	TERM7	TERM7 ON 10-PIN TERMINAL STRIP
11	TERM8	TERM8 ON 10-PIN TERMINAL STRIP
12	3.3V	REGULATED 3.3V
13	GND	SAME AS PIN3
14	RLED	BOTTOM/RED LED
15	VCC	INPUT 8-28V -> COMES FROM TERM9 OF THE 10-PIN TERMINAL STRIP
16	GLED	TOP/GREEN LED
17	VCC	SAME AS PIN15
18	N/C	NOT CONNECTED
19	VCC	SAME AS PIN15
20	N/C	NOT CONNECTED

TS-732 Jumper Settings

✔ The CAN_Term Jumper enables/disables a termination resistor for the CAN network

✔ The CL_1 to CL_4 jumpers must be ON if it is wanted the TERM1 to TERM4 to act as a current loop (0-20mA range), making the ADC lines measure actual current instead of voltage level (0-5V range)

TS-732 Internal Power Cable

The internal power cable of the TS-732 must be connected to the power input of the TS-7300 SBC in order to provide regulated 5VDC power supply to the SBC.

> **!** **Warning**
> The indicated polarity must be used when connecting this cable.

3.5 TS-730C Routing/Connectors Board

The TS-730C board interfaces between the TS-732/TS-7300 functions and the TS-ENC730 external connectors, routing the signals to the respective connectors which are brought out on the rear panel of the enclosure.

Internal TS-730C Headers

✔ The 20-pin CN1 header must be connected straight to the 20-pin header on TS-732

✔ The 10-pin CN2 header must be connected to the 10-pin COM2 header on TS-7300

✔ The 10-pin CN3 header connects to the 10-pin COM3 header on TS-7300

✔ The 10-pin CN4 header connects to the 10-pin COM4 header on TS-7300

✔ The 10-pin CN5 header connects to the 10-pin COM5 header on TS-7300

TS-730C Jumper Settings

✔ All the CAN jumpers must be ON to have the CAN Bus enabled on the COM2/CAN DB9 connector instead of COM2

✔ All the CAN jumpers must be OFF to have the COM2 port enabled on the COM2/CAN DB9 connector instead of CAN

✔ Jumper GND6 ON makes the TERM6 of the 10-PIN Terminal Strip act as a ground in order to increase ADC accuracy by reducing IR drop effects

4 PRODUCT SPECIFICATIONS

4.1 Dimensions

The TS-ENC730 enclosure dimensions are **2.0" x 5.3" x 7.1"**

4.2 Cabling

The enclosure includes the following cables for use with the TS-7300 SBC:

✔ All internal ribbon cables to make connections between the various 10-pin headers

✔ One internal ribbon cable to make connection between the 20-pin headers

4.3 Environmental

To ensure optimum product operation you must maintain the operational environmental specifications listed in the table below.

Table: Environmental Specification for TS-ENC730

Environmental Specification	Standard Temp Products	Extended Temp Products
Ambient Temperature	-20° to +70° C The internal temperature must not exceed +70° C.	-40° to +85° C Extended temperature range is also standardat lower CPU clock speeds. **Note:** At high temperature operations, CPU clock speed should be set to <=166MHz **Note:** Refer to your product manual, or contact Technologic Systems if the environmental temperature of the location is in doubt.
Relative Humidity	0 to 90% relative humidity. Not to exceed 90% non-condensing.	Not to exceed 90% non-condensing.

5 FURTHER REFERENCES

- ✔ **Getting Started with TS-Linux**
  (http://www.embeddedarm.com/Manuals/gs_tslinux.pdf)

- ✔ **Linux for TS-ARM User's Guide**
  (http://www.embeddedarm.com/Manuals/linuxforarm-manual.pdf)

- ✔ **TS-7300 Data Sheet**
  (**http://www.embeddedarm.com/Manuals/ts-7300-datasheet.pdf**)

- ✔ **TS-7300 schematic**
  (http://www.embeddedarm.com/downloads/Schem_Mech/TS-7300_Mech.pdf)

- ✔ **TS-7300 mechanical drawing**
  (http://www.embeddedarm.com/downloads/Schem_Mech/TS-7300_Mech.pdf)

- ✔ **TS-7300's download section** (http://www.embeddedarm.com/epc/ts7300-spec-d.htm)

- ✔ **EP9301 User's Guide**
  (http://www.embeddedarm.com/downloads/Components/EP9301_User_Guide.pdf)

- ✔ **EP9301 Data Sheet**
  (http://www.embeddedarm.com/downloads/Components/EP9302-PP2.pdf)

- ✔ **TS-7000 Yahoo Users' Group** (http://groups.yahoo.com/group/ts-7000/)

APPENDIX A: DOCUMENT HISTORY

Date of Issue/Revision	Revision Number	Comments
December 25, 2006	Preliminary Draft	Preliminary release for first customer ship – not complete
June 27, 2007	1.0	Minor corrections. Include of ts732 command section.
Nov 21, 2007	**1.1**	**Minor corrections**

APPENDIX B: ENCLOSURE VIEWS

Internal view of TS-ENC730 shown with TS-7300, TS-732 and TS-730C
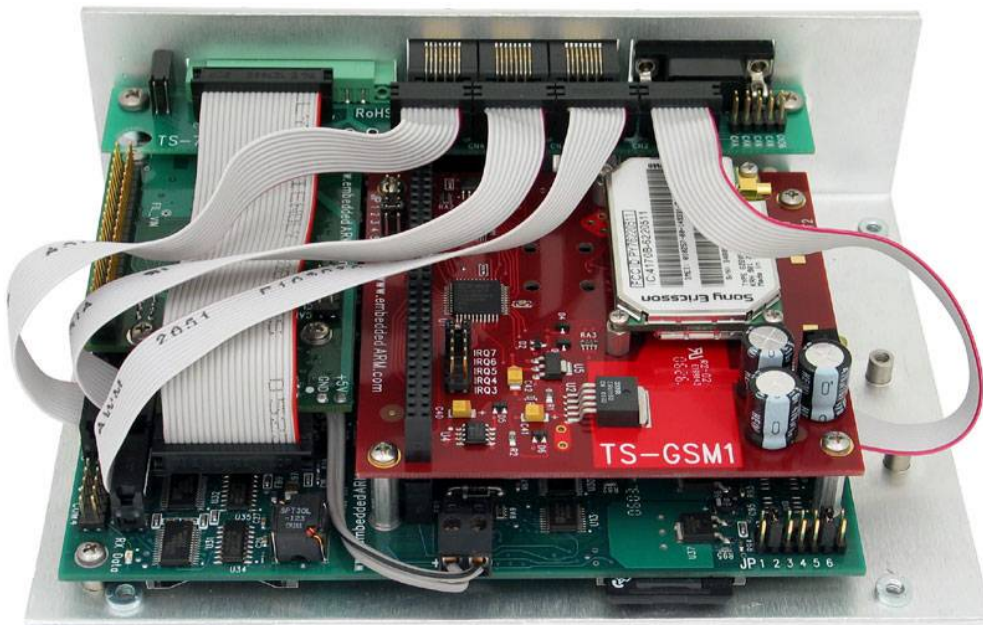
Internal view of TS-ENC730 shown with TS-7300, TS-732, TS-730C,
TS-GSM1 and all the included cables

APPENDIX C: CONTACT TECHNOLOGIC SYSTEMS

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S Y S T E M S

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Call us Monday-Friday, **from 9 am to 5 pm**, Arizona-USA time;
or email us at any time.

Our engineers answer tech support calls and are more than happy to talk to you
about your needs and help you find the best solution for your project.