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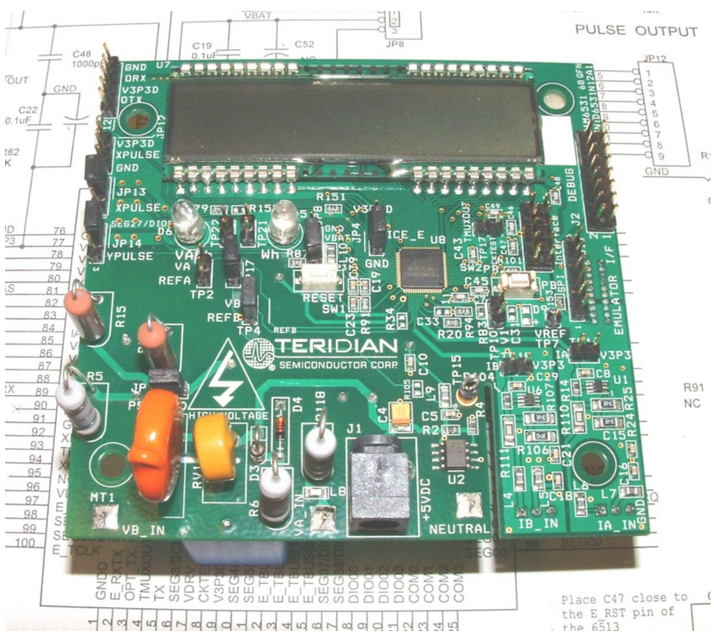
71M6531 Demo Board

USER'S MANUAL



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71M6531

Single-Phase Energy Meter IC

DEMO BOARD

USER'S MANUAL

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1 GETTING STARTED

1.1 GENERAL

The TERIDIAN Semiconductor Corporation (TSC) 71M6531 Demo Board is an energy meter IC demonstration board for evaluating the 71M6531D/F device for residential electronic energy metering applications. It incorporates a 71M6531D/F integrated circuit, peripheral circuitry such as a serial EEPROM, emulator port, and on-board power supply as well as a companion Debug Board that allows a connection to a PC through a RS232 port. The Demo Board allows the evaluation of the 71M6531D/F energy meter controller chip for measurement accuracy and overall system use.

The board is pre-programmed with a Demo Program (file name 6531_demo.hex) in the FLASH memory of the 71M6531D/F IC. This embedded application is developed to exercise all low-level functions to directly manage the peripherals and CPU (clock, timing, power savings, etc.).

1.2 SAFETY AND ESD NOTES

Connecting live voltages to the Demo Board system will result in potentially hazardous voltages on the Demo Board.

EXTREME CAUTION SHOULD BE TAKEN WHEN HANDLING THE DEMO BOARD ONCE IT IS CONNECTED TO LIVE VOLTAGES!

THE DEMO SYSTEM IS ESD SENSITIVE! ESD PRECAUTIONS SHOULD BE TAKEN WHEN HANDLING THE DEMO BOARD!

1.3 DEMO KIT CONTENTS

- 71M6531 Demo Board containing 71M6531D/F IC with preloaded Demo Program and prepared for either CT or shunt resistor operation
- Debug Board
- Shunt resistor with wire harness, 400µΩ (for kits shipped in shunt configuration)
- Two 5VDC/1,000mA universal wall transformers w/ 2.5mm plug (Switchcraft 712A)
- Serial cable, DB9, Male/Female, 2m length (Digi-Key AE1379-ND)
- CD-ROM containing documentation (data sheet, board schematics, BOM, layout), Demo Code, and utilities

Note: The CD-ROM contains a file named **readme.txt** that specifies all files found on the media and their purpose.

1.4 COMPATIBILITY

This manual applies to the following hardware and software revisions:

- 71M6531D/F, chip revision A03
- Demo Boards D6531N12A2
- Demo Board Code revision 6531_4p6q_12may08_0cc.hex, 6531_4p6q_12may08_0sc.hex (EQU 0) , 6531_4p6q_12may08_1cc.hex EQU 1), 6531_4p6q_12may08_2cc.hex (EQU 2), or later

1.5 SUGGESTED EQUIPMENT NOT INCLUDED

For functional demonstration:

- PC w/ MS-Windows® versions XP, ME, or 2000, equipped with RS232 port (COM port) via DB9 connector
- One or two current transformers (CTs), preferably 2,000:1 turns ratio
- For software development (MPU code):
- Signum ICE (In Circuit Emulator): ADM-51
- http://www.signum.com
- Keil 8051 "C" Compiler kit: CA51

http://www.keil.com/c51/ca51kit.htm, http://www.keil.com/product/sales.htm

1.6 DEMO BOARD TEST SETUP

Figure 1-1 shows the basic connections of the Demo Boards plus Debug Boards with the external equipment.

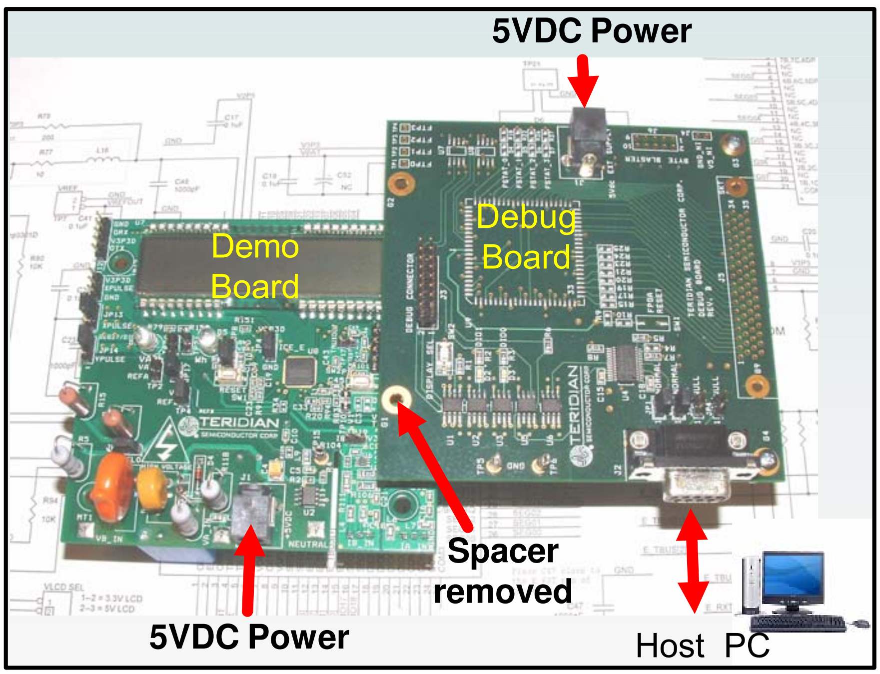

Figure 1-1: Demo Board: Basic Connections

The Debug Board can be plugged into J2 of the Demo Board. One spacer of the Debug Board should be removed, as shown in Figure 1-1. Alternatively, both boards can be connected using a flat ribbon cable, as shown in Figure 1-2. A male header has to be soldered to J3 of the Debug Board, and the female-to-female flat ribbon cable is not supplied with the Demo Kit (use Digi-Key P/N A3AKA-1606M-ND or similar).

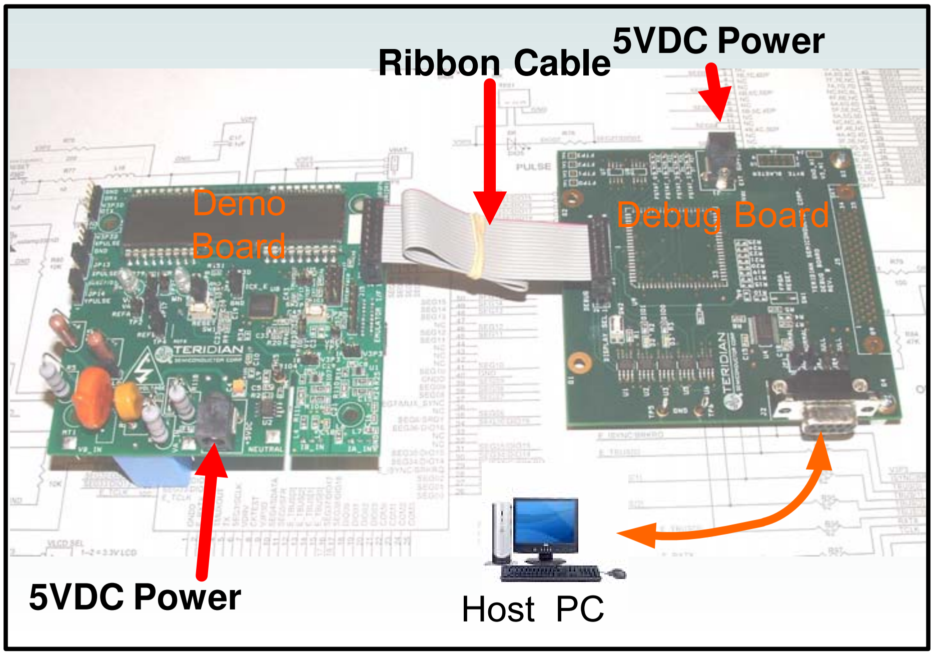

Figure 1-2: Demo Board: Ribbon Cable Connections

The 71M6531 Demo Board block diagram is shown in Figure 1-3. It consists of a stand-alone meter Demo Board and an optional Debug Board. The Demo Board contains all circuits necessary for operation as a meter, including display, calibration LED, and power supply. The Debug Board, when not sharing a power supply with the meter, is optically isolated from the meter and interfaces to a PC through a 9 pin serial port.

Connections to the external signals to be measured, i.e. scaled AC voltages and current signals derived from shunt resistors or current transformers, are provided on the rear side of the Demo Board.

It is recommended to set up the Demo Board with no live AC voltage connected, and to connect live AC voltages only after the user is familiar with the demo system.

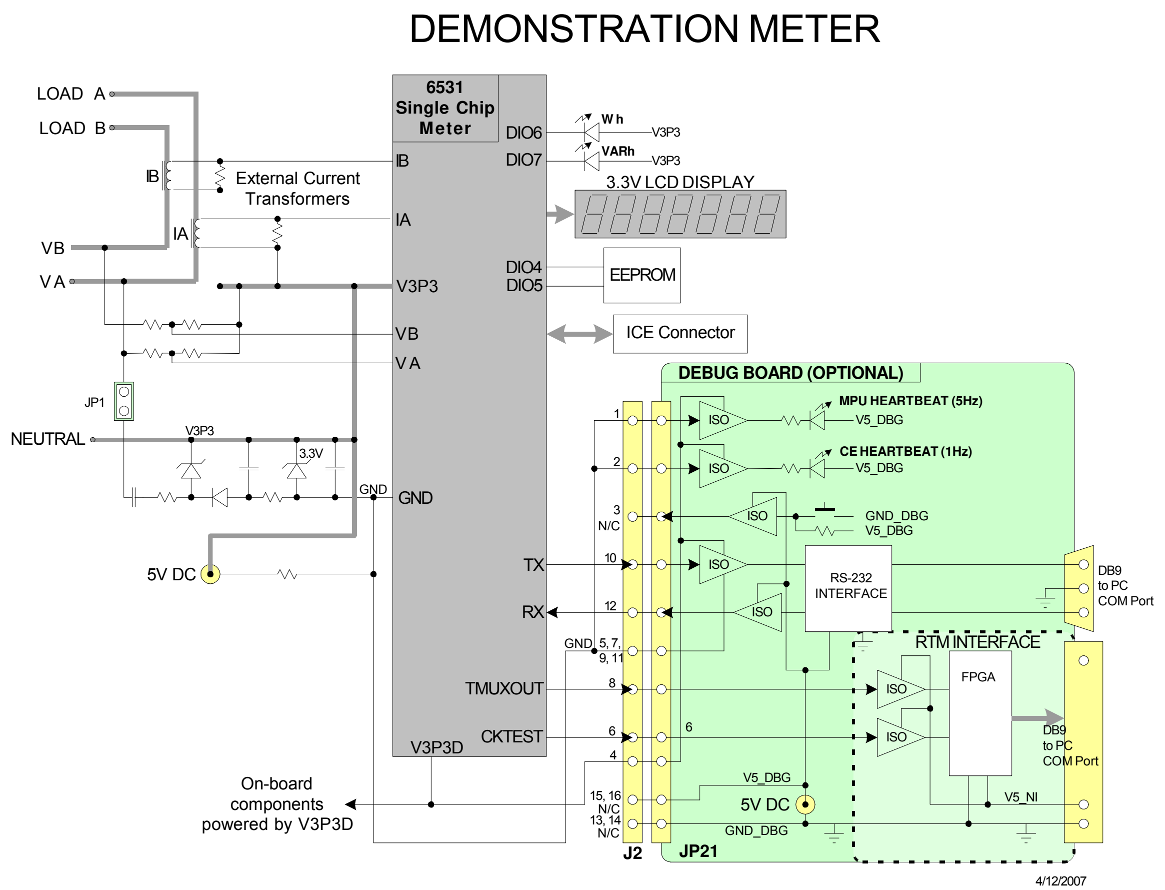

Figure 1-3: The TERIDIAN 6531 Demo Board with Debug Board Block Diagram (CT Configuration)

Note: All analog input signals are referenced to the V3P3A net (3.3V power supply to the chip).

1.6.1 POWER SUPPLY SETUP

There are several choices for meter the power supply:

- Internal (using the AC line voltage). The internal power supply is only suitable when the line voltage exceeds 220V RMS.
- External 5VDC connector (J1) on the Demo Board
- External 5VDC connector (J1) on the Debug Board.

The power supply jumper, JP1, must be consistent with the power supply choice. JP1 connects the AC line voltage to the internal power supply. This jumper should usually be left in place.

When the Demo Board is in shunt configuration, the shunt resistor has to be connected as shown in Figure 1-7 for the board to be powered via J1. Alternatively, a jumper cable between any header labeled V3P3 and the NEUTRAL terminal (J9) can be supplied.

1.6.2 CABLE FOR SERIAL CONNECTION

For connection of the DB9 serial port to a PC, either a straight or a so-called "null-modem" cable may be used. JP1 and JP2 are plugged in for the straight cable, and JP3/JP4 are empty. The jumper configuration is reversed for the null-modem cable, as shown in Table 1-3.

Cable Configuration	Mode	Jumpers on Debug Board			
		JP1	JP2	JP3	JP4
Straight Cable	**Default**	Installed	Installed	--	--
Null-Modem Cable	Alternative	--	--	Installed	Installed

Table 1-1: Jumper settings on Debug Board

JP1 through JP4 can also be used to alter the connection when the PC is not configured as a DCE device. Table 1-2 shows the connections necessary for the straight DB9 cable and the pin definitions.

PC Pin	Function	Demo Board Pin
2	TX	2
3	RX	3
5	Signal Ground	5

Table 1-2: Straight cable connections

Table 1-3 shows the connections necessary for the null-modem DB9 cable and the pin definitions.

PC Pin	Function	Demo Board Pin
2	TX	3
3	RX	2
5	Signal Ground	5

Table 1-3: Null-modem cable connections

1.6.3 CHECKING OPERATION

A few seconds after power up, the LCD display on the Demo Board should briefly display the following welcome text:

		H	E	L	L	O	

After the "HELLO" text, the LCD should display the following information:

		W	h				

and:

				0.	0	0	1

The text "Wh" indicates that accumulated Watt-hours are displayed. In the case shown above, 0.001 Wh were accumulated. The display will be cycling from numeric to text, indicating activity of the MPU inside the 71M6531D/F.

In Mission Mode, the display can be cycled to display VARh, PF and other parameters by pressing the pushbutton (PB).

1.6.4 SERIAL CONNECTION SETUP FOR THE PC

After connecting the DB9 serial port to a PC, start the HyperTerminal application (or any other suitable communication program) and create a session using the communication parameters shown in Table 1-4.

Setup Parameter	Value
Port speed (baud)	9600/300†
Data bits	8
Parity	none
Stop bits	1
Flow control	XON/XOFF
	† depending on the jumper setting at JP12

Table 1-4: COM Port Setup Parameters

HyperTerminal can be found by selecting Programs →Accessories → Communications from the Windows© start menu. The connection parameters are configured by selecting File → Properties and then by pressing the Configure button (see Figure 1-4).

A setup file (file name "Demo Board Connection.ht") for HyperTerminal that can be loaded with File → Open is also provided with the tools and utilities on the supplied CD-ROM.

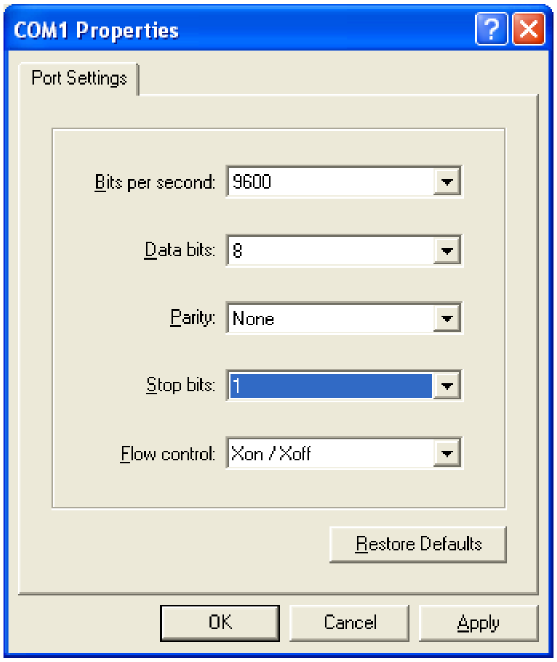

Figure 1-4: Port Configuration Setup

Note: Port parameters can only be adjusted when the connection is not active. The disconnect button, as shown in Figure 1-5 must be clicked in order to disconnect the port.

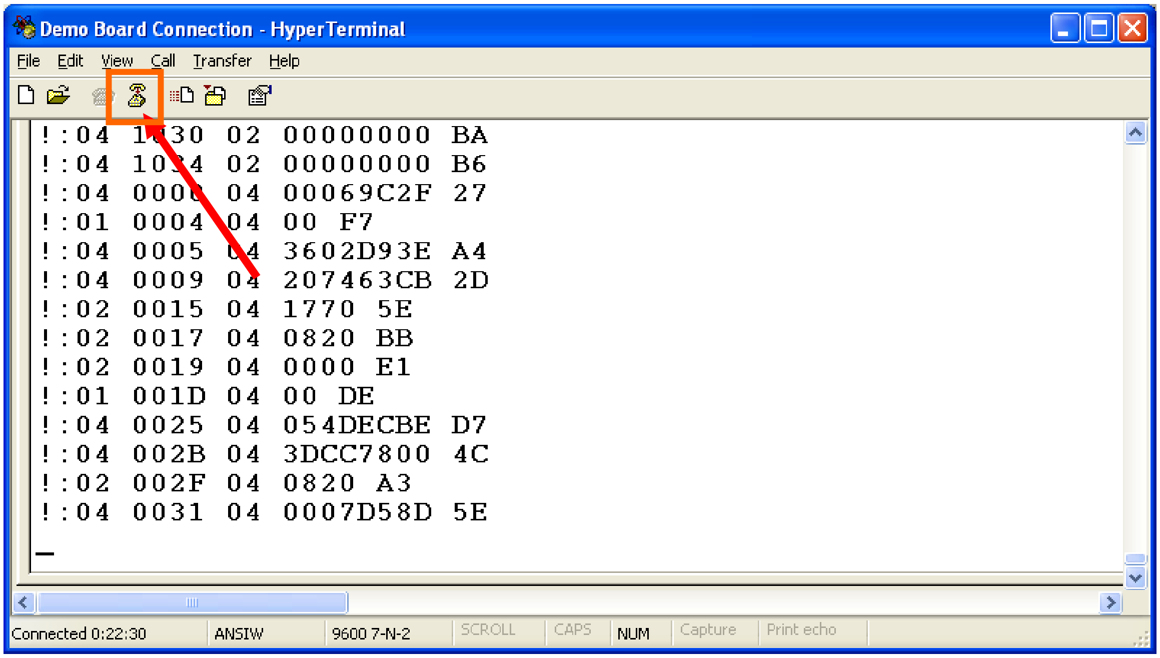

Figure 1-5: Hyperterminal Sample Window with Disconnect Button

1.7 USING THE DEMO BOARD

The 71M6531 Demo Board is a ready-to-use meter prepared for use with an external shunt resistor.

Using the Demo Board involves communicating with the Demo Code. An interactive command line interface (CLI) is available as part of the Demo Code. The CLI allows modifications to the metering parameters, access to the EEPROM, initiation of auto-calibration sequences, selection of the displayed parameters, changing calibration factors and many more operations.

Before evaluating the 71M6531 Demo Board, users should get familiar with the commands and responses of the CLI. A complete description of the CLI is provided in section 1.7.2.

1.7.1 CYCLING THE LCD DISPLAY

The Demo Codes for the 71M6531 Demo Board allow cycling of the display using the PB button. By briefly pressing the button, the next available parameter from Table 1-5 is selected. This makes it easy to navigate various displays for Demo Boards that do not have the CLI.

Step	Text Display	Displayed Parameter
1	Wh	Accumulated real energy [Wh]. The default display setting after power-up or reset.
2	VARh	Accumulated reactive energy [VARh].
3	Hours	Expired hours after power-up or reset
4	Time	Time of day (hh.mm.ss).
5	Date	Date (yyyy.mm.dd).
6	PF	Current power factor.
7	Edges	Count of zero crossings in the last accumulation interval.
8	Pulses	Number of emitted pulses.
8	A	RMS current at phase A input [A].
8	V	RMS voltage at the VA_IN input [V].
8	Bat V	Measured battery voltage [V].
8	Delta T	Temperature difference from calibration temperature. Displayed in 0.1°C

Table 1-5: Selectable Display Options

1.7.2 SERIAL COMMAND LINE INTERFACE (CLI)

Once, communication to the Demo Board is established, press <CR> and the Demo Program prompt ("**>**") should appear. Type **>i** to verify that the Demo Program version is revision 4p6q or later.

Users should familiarize themselves with the Demo Program commands described in the tables below.

The Demo Program (Demo Code) is compiled with EEPROM specified as the non-volatile memory. This means that the default calibration factors are stored in flash memory while the calibration factors resulting from an actual calibration are stored in EEPROM.

The tables below describe the commands in detail. Type '?' for a display of available commands.

Commands for CE Data Access:

]	**CE DATA ACCESS**	**Remarks**
Description:	Allows user to read from and write to CE data space.	
Usage:	] [Starting CE Data Address] [option]…[option]	
Command combinations:	]???	Read consecutive 16-bit words in Decimal
	]$$$	Read consecutive 16-bit words in Hex
	]U	Update default version of CE Data in EEPROM. **Important: The CE must be stopped (CE0) before issuing this command!**
Example:	]40$$$	Reads CE data words 0x40, 0x41 and 0x42.
	]7E=12345678=9876ABCD	Writes two words starting @ 0x7E

CE data space is the address range from 0x1000 to 0x13FF. All CE data words are in 4-byte (32-bit) format. The offset of 0x1000 does not have to be entered when using the] command, thus typing]A? will access the 32-bit word located at the byte address 0x1000 + 4 * A = 0x1028.

Commands for MPU/XDATA Access:

)	**MPU DATA ACCESS**	**Remarks**
Description:	Allows user to read from and write to MPU data space.	
Usage:	) [Starting MPU Data Address] [option]…[option]	
Command combinations:	)???	Read three consecutive 32-bit words in Decimal
	)$$$	Read three consecutive 32-bit words in Hex
	)a=n=m	Write the values n and m to two consecutive addresses starting at a
Example:	)08$$$$	Reads data words 0x08, 0x0C, 0x10, 0x14
	)04=12345678=9876ABCD	Writes two words starting @ 0x04

MPU or XDATA space is the address range for the MPU XRAM (0x0000 to 0x0FFF). All MPU data words are in 4-byte (32-bit) format. Typing]A? will access the 32-bit word located at the byte address 4 * A = 0x28. The energy accumulation registers of the Demo Code can be accessed by typing two question marks ("??").

Commands for I/O RAM (Configuration RAM) and SFR Control:

R	DIO AND SFR CONTROL	Remarks
Description:	Allows the user to read from and write to I/O RAM and special function registers (SFRs).	
Usage:	R [option] [register] … [option]	
Command combinations:	RIx…	Select I/O RAM location x (0x2000 offset is automatically added)
	Rx…	Select internal SFR at address x
	Rx???...	Read consecutive SFR registers in decimal
	Rx$$$...	Read consecutive registers in hex notation
Example:	RI60$$$$	Read all four RTM probe registers

DIO or Configuration RAM space is the address range 0x2000 to 0x20FF. This RAM contains registers used for configuring basic hardware and functional properties of the 71M6531D/F and is organized in bytes (8 bits). The 0x2000 offset is automatically added when the command RI is typed. The SFRs (special function registers) are located in internal RAM of the 80515 core, starting at address 0x80.

Commands for EEPROM Control:

EE	EEPROM CONTROL	Remarks
Description:	Allows user to enable read and write to EEPROM.	
Usage:	EE [option] [arguments]	
Command combinations:	EECn	EEPROM Access (1 → Enable, 0 → Disable)
	EERa.b	Read EEPROM at address 'a' for 'b' bytes.
	EEE	Erase the EEPROM
	EESabc..xyz	Write characters to buffer (sets Write length)
	EETa	Transmit buffer to EEPROM at address 'a'.
	EEWa.b...z	Write values to buffer
Example:	EEShello; EET$0210	Writes 'hello' starting at EEPROM address 0x210.

The EEC1 command must be issued before the EEPROM interface can be used. The execution of the EEE command takes several seconds. During this time, no other commands can be entered.

Auxiliary Commands:

	AUXILIARY	Remarks
Description:	Various	
Commands:	,	Typing a comma (",") repeats the command issued from the previous command line. This is very helpful when examining the value at a certain address over time, such as the XRAM address for the temperature.
	/	The slash ("/") is useful to separate comments from commands when sending macro text files via the serial interface. All characters in a line after the slash are ignored.
	?	Displays the help menu.
	CLC	Enables communication via hex records.
	BT	Commands execution of a battery test.

Commands controlling the CE:

C	**COMPUTE ENGINE CONTROL**	**Remarks**
Description:	Allows the user to enable and configure the compute engine.	
Usage:	C [option] [argument]	
Command combinations:	CEn	Compute Engine Enable (1 → Enable, 0 → Disable)
	CTn	Select input n for TMUX output pin. Enter n in hex notation.
	CREn	RTM output control (1 → Enable, 0 → Disable)
	CRSa.b.c.d	Selects CE addresses for RTM output (maximum of four)
Example:	CE0	Disables the CE
	CT1E	Selects the CE_BUSY signal for the TMUX output pin

Calibration Commands:

CL	**CALIBRATION CONTROL**	**Remarks**
Description:	Calibration-related commands. A full auto-calibration can be implemented by compiling the Demo Code with auto-calibration selected as an option. Due to space restrictions, the auto-calibration is not implemented in the Demo Code supplied with the Demo Boards.	
Usage:	CL [option]	
Command combinations:	CLC	Loads a calibration via serial port
	CLB	Starts an auto-calibration sequence
	CLD	Restores calibration to defaults
	CLR	Restores calibration from EEPROM
	CLS	Saves calibration to EEPROM

Commands for Identification and Information:

I	**INFORMATION MESSAGES**	**Remarks**
Description:	Allows user to display information messages.	
Usage:	I	
Example:	I	Returns the Demo Code version

The I command is used to identify the revisions of Demo Code and the contained CE code.

Commands for Controlling the Metering Values Shown on the LCD Display:

M	**METER DISPLAY CONTROL (LCD)**	**Remarks**
Description:	Allows user to select internal variables to be displayed.	
Usage:	M [option]. [option]	
Command combinations:	M	kWh Total Consumption (display wraps around at 999.999)
	M1	Temperature (C° delta from nominal)
	M2	Frequency (Hz)
	M3. [phase]	kWh Total Consumption (display wraps around at 999.999)
	M4. [phase]	kWh Total Inverse Consumption (display wraps around at 999.999)
	M5. [phase]	kVARh Total Consumption (display wraps around at 999.999)
	M6. [phase]	kVAh Total Inverse Consumption (display wraps around at 999.999)
	M7. [phase]	VAh Total (display wraps around at 999.999)
	M9	Real Time Clock
	M10	Calendar Date
	M13. n	Main edge count (n = 0: accumulated, n = 1: last second)
	M17	Battery voltage. Display will return to M3 after a few seconds.
Example:	M3.1	Displays Wh total consumption of phase A.

Displays for total consumption wrap around at 999.999kWh (or kVARh, kVAh) due to the number of available display digits. Internal registers (counters) of the Demo Code are 64 bits wide and do not wrap around.

The internal accumulators in the Demo Code use 64 bits and will neither overflow nor wrap around under normal circumstances. The restriction to only six digits is due to the requirement to provide one digit showing the display mode that is separated by a blank digit from the displayed values.

Commands for Controlling the RMS Values Shown on the LCD Display:

MR	**METER RMS DISPLAY CONTROL (LCD)**	**Remarks**
Description:	Allows user to select meter RMS display for voltage or current.	
Usage:	MR [option]. [option]	
Command combinations:	MR1. [phase]	Displays instantaneous RMS current
	MR2. [phase]	Displays instantaneous RMS voltage
Example:	MR1.2	Displays phase b RMS current.

Commands for Controlling the MPU Power Save Mode:

PS	**POWER SAVE MODE**	**Remarks**
Description:	Enters power save mode	Disables CE, ADC, CKOUT, ECK, RTM, TMUX VREF, and serial port, sets MPU clock to 38.4KHz.
Usage:	PS	

Return to normal mode is achieved by issuing a hardware reset.

Commands for Controlling the RTC:

RT	REAL TIME CLOCK CONTROL	Remarks
Description:	Allows the user to read and set the real time clock.	
Usage:	RT [option] [value] … [value]	
Command combinations:	RTDy.m.d.w: Day of week	(year, month, day, weekday [1 = Sunday]). Weekday is automatically set if omitted.
	RTR	Read Real Time Clock.
	RTTh.m.s	Time of day: (hr, min, sec).
	RTAs.t	Real Time Adjust: (speed, trim)
Example:	RTD05.03.17.5	Programs the RTC to Thursday, 3/17/2005

Reset Commands:

Z, W	RESET	Remarks
Description:	Allows the user to cause soft or watchdog resets	
Usage:	Z	Soft reset
	W	Simulates watchdog reset

The Z command acts like a hardware reset. The energy accumulators in XRAM will retain their values.

Commands for Controlling the LCD and Sleep Modes (when in Brownout Mode):

B	POWER MODE CONTROL	Remarks
Description:	Allows the user switch to LCD and Sleep mode when the 71M6531D/F is in Brownout mode.	
Usage:	B [option] [value]	
Command combinations:	BL	Enters LCD mode
	BS	Enters Sleep mode
	BWSn	Prepares Sleep mode with the wakeup timer set to n seconds
	BWMm	Prepares Sleep mode with the wakeup timer set to m minutes
Example:	BWS8 BS	Enters Sleep mode with the wakeup timer set to 8 seconds. The 71M6531D/F will enter Sleep mode and return to Brownout mode after 8 seconds.

Commands for Error Recording:

ER	ERROR RECORDING	Remarks
Description:	Allows the user display and clear the error log.	
Usage:	ER [option] [value]	
Command combinations:	ERC	Clears all errors from error log
	ERD	Displays error log
	ERS+n	Enters error number n in error log
Example:	ERS+10	Enters error number 10 in error log

1.7.3 COMMUNICATING VIA INTEL HEX RECORDS

Communication with the 71M6531D/F IC, especially by computers and/or ATE, may also be accomplished using a simplified protocol based on Intel Hex records. These records can still be sent and received with an ordinary terminal, and coding and decoding of commands and responses is straight-forward.

Using the Hex-Record Format

Intel's Hex-record format allows program or data files to be encoded in a printable (ASCII) format, allowing editing of the object file with standard tools and easy file transfer between a host and target. An individual hex-record is a single line in a file composed of one or several Hex-records.

Entering "CLC" from the text-based command line interface enables the hex-record interface.

Hex-Records are character strings made of several fields which specify the record type, record length, memory address, data, and checksum. Each byte of binary data is encoded as a 2-character hexadecimal number: the first ASCII character representing the high-order 4 bits, and the second the low-order 4 bits of the byte. The six fields that comprise a Hex-record are defined in Table 1-6.

Field	Name	Characters	Description
1	Start code	1	An ASCII colon (":")
2	Byte count	2	The count of the character pairs in the data field.
3	Address	4	The 2-byte address at which the data field is to be loaded into memory. This is the physical XRAM or I/O RAM address, not the 4-byte address used by the command-line interface (CLI).
4	Type	2	00, 01, or 02.
5	Data	0-2n	From 0 to n bytes of executable code, or memory loadable data. n is normally 20 hex (32 decimal) or less.
6	Checksum	2	The least significant byte of the two's complement sum of the values represented by all the pairs of characters in the record except the start code and checksum.

Table 1-6: Fields of a Hex Record

Each record may be terminated with a CR/LF/NULL character. Accuracy of transmission is ensured by the byte count and checksum fields. This is important when series of values such as calibration constants are transmitted to a meter, e.g. by ATE equipment in a factory setting. When entering hex records manually, the user may also choose "FF" ("wild card") as the checksum. In this case, the Demo Code omits comparing the checksum with the received record(s).

This is how the checksum is calculated manually (if necessary):

1) The hex values of all bytes (except start code and checksum itself) are added up.
2) The last two hex digits are subtracted from 0xFF.
3) The value 0x01 is added.

As opposed to the standardized Hex-records that offer three possible types (data, termination, segment base), six different types are supported for communicating with the 71M6531D/F. These data types basically encode command types (read/write) along with the data source or destination, as listed in Table 1-7.

Number	Code	Function
1	00	Write CE data record, contains data and 16-bit CE address (CE data RAM is located at 0x1000).
2	01	End Of File (Quit) record, a file termination record. Contains no data. This record has to be the last line of the file, and only one record per file is permitted. The byte pattern is always ':00000001FF'. Upon receipt of this record, the Demo Code will transfer the received data into non-volatile memory (EEPROM).
3	02	Alternate form of Write CE data record (optional). CE data RAM is located at 0x1000.
4	03	Read CE data record, contains empty data field and 16-bit CE address (optional). CE data RAM is located at 0x1000.
5	04	Write MPU or I/O RAM data record, contains data and 16-bit MPU address.
6	05	Read MPU or I/O RAM data record, contains empty data field and 16-bit MPU address (optional). I/O RAM is located at 0x2000.
7	06	Write RTC data record, contains data and 16-bit RTC address.
8	07	Read RTC data record, contains empty data field and 16-bit RTC address (optional).
9	08	Write SFR data record, contains data and 16-bit SFR address (optional). The MSB is always zero (0).
10	09	Read SFR data record, contains empty data field and 16-bit SFR address (optional).

Table 1-7: Data (command) types

Table 1-8 lists a few examples of hex records.

Hex Record	Function
`:08 0000 06 00 00 0C 03 18 05 06 00 ff`	Writes (06) eight bytes (08) to RTC, setting the RTC to zero seconds (00), minutes (00), 12 hours (0C), Wednesday (03), 24th (18) of May (05), 2006 (06). Uses the wild card checksum.
`:10 0010 00 00004000 00004000 00004000 00004000 E8` `:00 0000 01 FF`	Writes the default values (0x4000) for the calibration constants CAL_IA, CAL_IB, CAL_VA, and CAL_VC to the XRAM (00), starting at address 0x10 (0010). The second command causes the Demo Code to write the data to permanent storage.
`:10 1020 03 FF`	Causes the Demo Board to display the CE data from address 0x1020 to 0x102F

Table 1-8: Hex Record examples

The Demo Board will not echo any inputs from the terminal (they screen will stay blank except for the asterisk (*) issued after the user enters <CR><LF>). It is useful to configure Hyperterminal for "auto-echo". This can be done by selecting "Properties" from the "File" menu, then clicking on the "Settings" tab and clicking the "ASCII Setup" button.

No <ENTER> key is necessary at the end of a manually entered record.

Spaces in between the fields (to increase readability), as in the example above, are ignored by the Demo Boards.

If a hex record is accepted, the Demo Board returns a "**!**". If the hex record is not accepted, the Demo Board sends a "**?**" and other text, depending on the context (only the 16KB Demo Code will send text). When only a partial record is entered, the Demo Board will time out after around 30 seconds and then send <CR>< LF>.

A number of pre-assembled hex records is supplied with the Demo Code. It is easier to send a pre-assembled record using the "send text file" feature in the "Transfer" menu of Hyperterminal, than assembling hex record from scratch.

The pre-assembled hex records are contained in a ZIP file named 6531_scripts.zip on the CD-ROM supplied with the Demo Kits. Table 1-9 shows the records available and their function.

Hex Record Name	Function
`set_6531_defaults.txt`	Sets the default configuration, including all CE variables. Transferring this record is necessary when data in the EEPROM is lost or compromised.
`read_6531_temp.txt`	Displays the current temperature reading from the CE
`set_6531_temp.txt`	This record can be edited to set the nominal (calibration) temperature
`read_6531_power.txt`	Displays the valid power data
`read_6531_ce.txt`	Displays CE data from memory locations 0x1020 to 0x10FF
`read_6531_config.txt`	Displays configuration data. This hex record includes comment text helping to interpret the received data.
`set_6531_rtm.txt`	Sets up the real-time monitor

Table 1-9: Pre-assembled hex records

1.7.4 USING THE BATTERY MODES

The 71M6531D/F is in so-called Mission mode, as long as 3.3VDC is supplied to the V3P3SYS pin. If this voltage is below the minimum required operating voltage which is usually indicated by V1 < 1.6 (internal VBIAS voltage), and if no battery is connected to the VBAT pin, the chip is powered off.

Battery modes can be used if a battery or other DC source supplying a DC voltage with in the operating limits for the battery input is applied to the battery pin (VBAT, pin 49) of the chip. On the Demo Board, the battery should be connected to pin 2 (+) and 3 (-) of JP8.

In order to prevent corruption of external memory, which could occur when main power is removed from the Demo Board while no battery is present, the Demo Code is shipped with the <u>battery modes DISABLED</u>. When the battery modes are disabled, the MPU will be halted once it enters brownout mode, even when a battery is present. See section 1.10.2 for instruction on how to enable battery modes.

If the main power source (internal or external power supply) is removed while a battery is connected to JP8 as described above, and if the battery modes are enabled with header JP12, the 71M6531D/F automatically enters Brownout mode. The Demo Code will then automatically transition from Brownout mode to Sleep mode.

By pressing the pushbutton PB, the chip is temporarily brought back to LCD mode. After a few seconds in LCD mode, the chip returns to Sleep mode.

By pressing the RESET pushbutton while the chip is in Sleep mode, the chip will enter Brownout mode.

Both the RESET and PB buttons are powered by the battery voltage (VBAT).

In Brownout mode, the analog functions are disabled, and the MPU functions at very low speed. DIO pins and the UART are still functional. If the chip supports the command line interface, it will signal Brownout mode, and the command prompt "B" will be visible on the terminal connected to the Demo Board, followed by the ">" sign:

B>

The LCD displays a decimal dot in the left-most digit to indicate that it is in Brownout mode, as shown below:

.		H	E	L	L	O	

The following commands can be entered via the CLI in Brownout mode:

- BL – enters LCD mode
- BS – enters Sleep mode.
- BWSn – enters sleep mode for n seconds, then returns to Brownout mode
- BWMm – enters sleep mode for m minutes, then returns to Brownout mode

In Sleep Mode, almost all functions are disabled. Only the RTC and the wakeup timer are still active. The wakeup signal from the timer and the pushbutton (SW2 on the Demo Board) take the 71M6531D/F back to Brownout mode.

A hardware reset, while in any battery mode, takes the 71M6531D/F back to Brownout mode.

1.8 USING THE DEMO BOARD FOR METERING FUNCTIONS

1.8.1 MODIFYING DEMO CODE TO CT OR SHUNT MODE

Script files contained in the CD-ROM shipped with the Demo Kit can be used to modify the constants used in the Demo Code from CT to shunt mode or vice versa. Three script files are available:

1. **6531ctct.txt** sets 6531 Demo Code for IA: 2000:1 CT (Imax = 208A) and IB: 2000:1 CT (ImaxB = 208A)

2. **6531ctshunt.txt**: IA: 2000:1 CT (Imax = 208A) IB: 400 µΩ shunt (ImaxB = 442A)

3. **6531shuntct.txt**: IA: 400 µΩ shunt (Imax = 442A) IB: 2000:1 CT (ImaxB = 208A)

To apply a script file, select "transfer -> send_text_file" from the HyperTerminal user interface.

1.8.2 USING THE DEMO BOARD IN SHUNT AND CT MODES

The Demo Board may be used with current shunt sensors of 400µΩ resistance or current transformers (CTs). It is programmable for a Kh factor of 1.0 and (see Section 0 for adjusting the Demo Board for current transformers). Section 1.8.6 describes proper wiring and safety precautions for shunt operation.

Once, voltage is applied and load current is flowing, the red LED D5 will flash each time an energy sum of 1.0 Wh is collected. The LCD display will show the accumulated energy in Wh when set to display mode 3 (command **>M3** via the serial interface).

Similarly, the red LED D6 will flash each time an energy sum of 1.0 VARh is collected. The LCD display will show the accumulated energy in VARh when set to display mode 5 (command **>M5** via the serial interface).

The D6531N12A2 Demo Boards can be operated with CTs on channel B, which is equipped with the proper burden resistors for 2000:1 CTs.