

HamWare Design Software is Tyco Electronics' harness design CAD software. Originally developed for use by our own harness designers it is now offered to our customers so they can benefit from this powerful tool.

From a simple input of geometry, dimensions, connector and wiring details, HamWare software can suggest a design sequence and help with many aspects of wiring harness design (see diagram).

HamWare software is used interactively by harness design engineers. The choices and calculations made by the system can always be modified to suit specific requirements. Design data is saved with each shape in the harness drawing. This data can be reviewed simply by moving the mouse over the parts listed in the Design Wizard. It is, therefore, very easy to incorporate design changes, modify design constraints or analyze alternative design solutions. Moreover a design checker can be used to search for deviations from 'best practice'.

Some HamWare Software Outputs

The following are some examples of the outputs that HamWare software can generate:

- High quality engineering drawings. Clear and reliable drawings play a crucial role in the success of any design project
- Point-to-point wiring lists, including calculated wire lengths.
- Fully detailed parts lists. HamWare software automatically generates the parts list table and adds item number balloons into the drawing. Parts lists can also be exported to a spreadsheet, database or word processor.
- Assembly time estimates. HamWare software automatically adds the design details into a 'spread sheet' containing standard assembly time synthetics.

- Wiring schematics and schedules are quickly produced using connector plan form data and wiring details from the wire list
- Lists of codes of practice describing harness assembly techniques and other issues that are relevant to the parts included in the design.
- Files containing cable marker details can be exported ready for use in marker printing systems such as the Tyco Electronics WinTotal* system. A drawing page showing these cable marker details can also be generated.

A sample set of documents produced by HamWare software is shown at the end of this section.

*Tyco Electronics Identification product information available at www.tycoelectronics.com

HamWare Harness Design Software (Continued)

System Building Blocks

Some key features of HamWare software are:

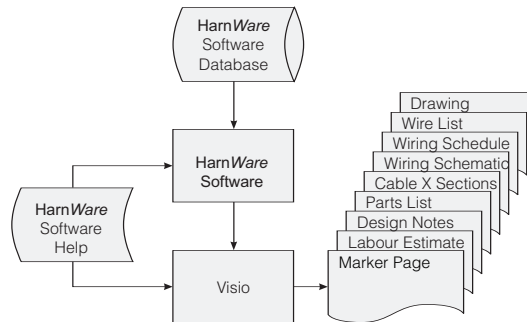
- Runs under Microsoft Windows on affordable PC's.
- The user interface is similar to that of commonly used software such as Microsoft Word and Excel.
- Uses the Visio drag and drop drawing system for creating harness drawings more quickly and more easily than with other computer aided design (CAD) systems.

- Software to help identify the parts most suitable for use within the given design constraints and to fit the mating parts, cables, etc.
- On-line help systems for guidance on using the system and on Raychem wiring harness products.

Designing a Harness With HamWare Software

Shapes, representing Raychem harnessing products, are dragged and dropped into the harness assembly drawing. The shapes automatically snap and glue together and it takes very little time to produce a high quality drawing. Pages from a sample HamWare software document set can be seen on page 2-14. Dimensions and connector references are entered by clicking a shape and typing in the numbers and references.

The HamWare Software Design Wizard analyzes the drawing and lists the parts and operations in the suggested design sequence. The wizard also provides quick access to details on each part in the harness and the connections between parts. When the mouse is moved over the parts listed by the wizard, HamWare software outputs such details as part dimensions, materials, finishes, etc.



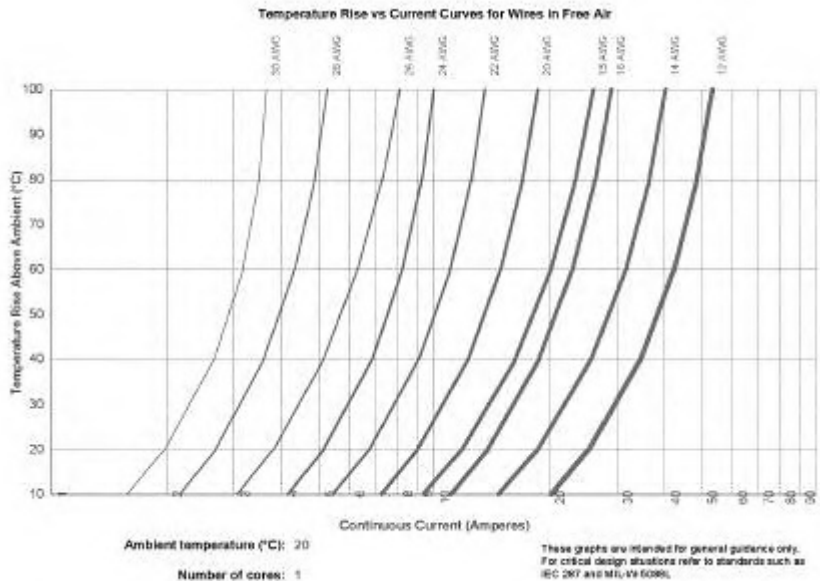
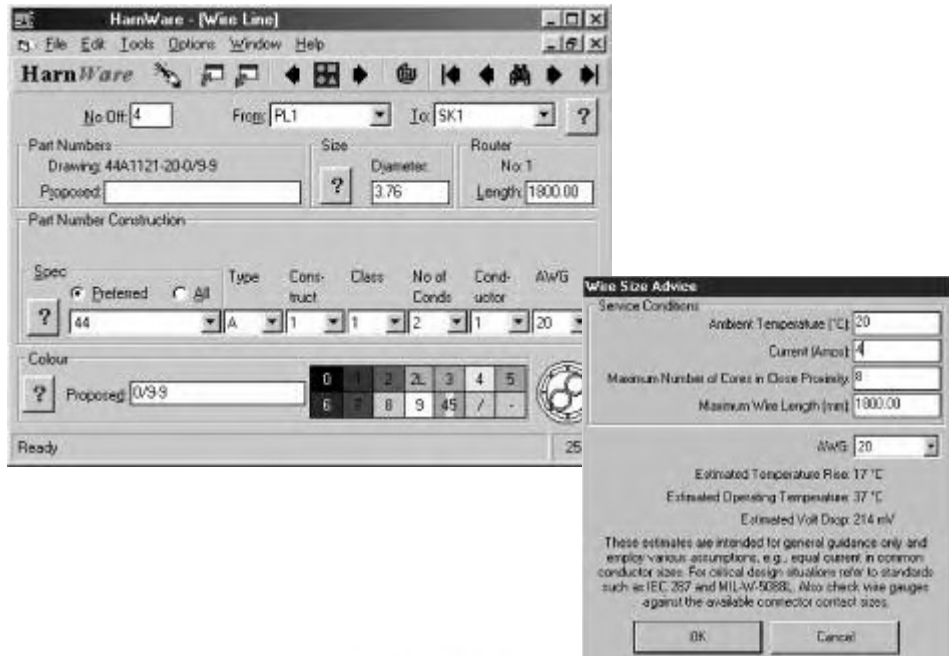
- A growing library of 400 intelligent drawing shapes and a 110,000 record design database which can generate 100,000s of part descriptions for Raychem wiring harness products in their various material and finish permutations.
- Software that traces wire routes through harnesses and automatically creates wiring schematics and calculates wire lengths.
- Analysis options to determine the optimum lay of cables containing mixed diameter wires and to suggest the most appropriate wire gauge for specified current and temperature rise limits.



HamWare software indicates the Raychem harness material system that is most suited to the given application, operating temperature range and required defense specifications.



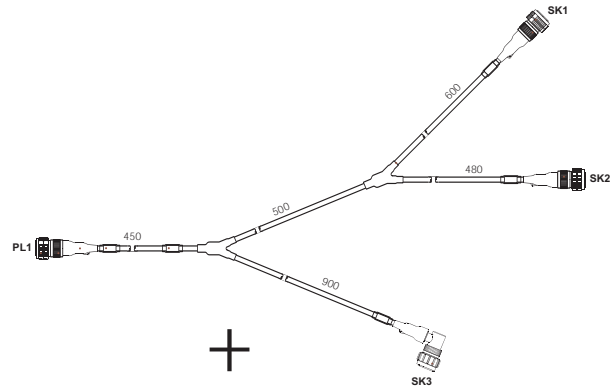
HamWare Harness Design Software (Continued)



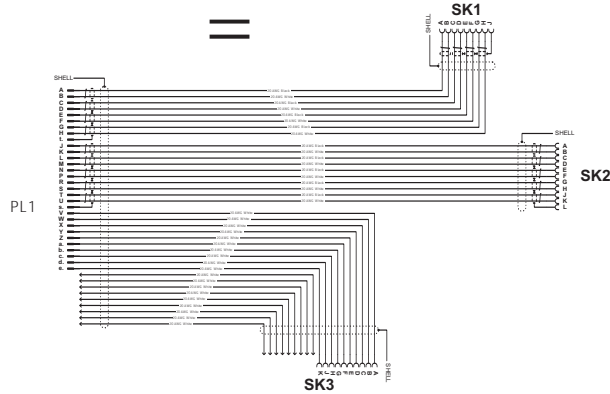
Wire Selection

The wire most suited to the particular environment and service conditions is selected using design rules encoded in the HamWare software and database. If the wire selected is a non-preferred option, alternative types and colors can be identified which may also suit the design requirements and be available on shorter delivery times.

Guidance is also available for choosing the wire gauge most suited to given current loading, ambient temperature, length, number of conductors, etc. For each available wire size HamWare software estimates temperature rises, operating temperatures and voltage drops.



WIRE LIST						
WIRE NO	ITEM NO	QTY	FROM	TO	PART NO	LENGTH
1	2	4	PL1	SK1	44A1121-20-09-9	1800.00
2	2	5	PL1	SK2	44A1121-20-09-9	1668.00
3	1	19	PL1	SK3	44A0711-20-9	1590.00



Wire Selection (Continued)

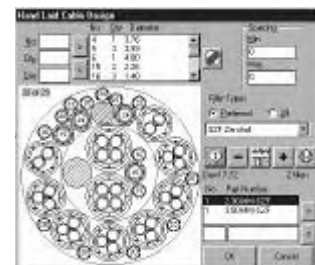
From-To connector references are specified to form a point-to-point wiring list. Wiring schematics can be generated automatically from the information included in the wire list. These schematic diagrams show the pin to pin wiring for all the connectors and wires in a harness design.

HamWare software automatically:

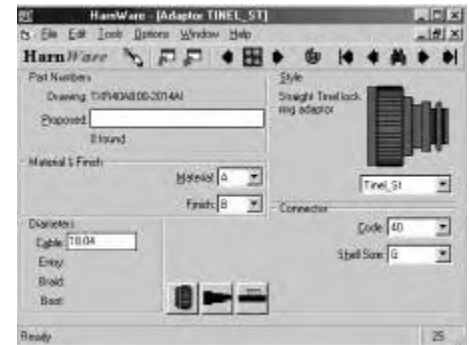
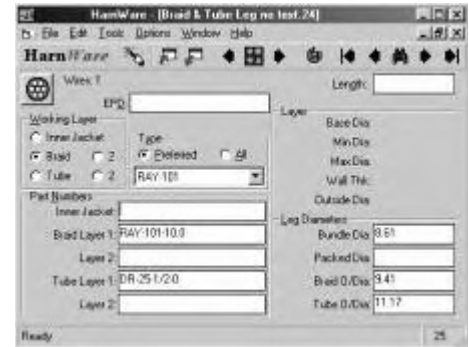
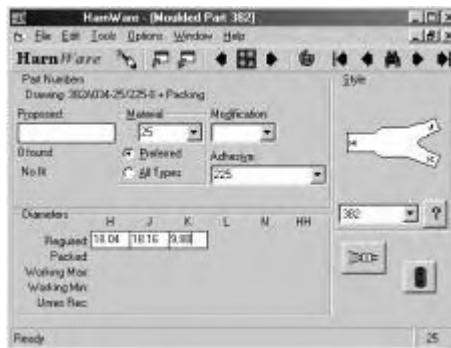
- Traces the route of each wire in the point-to-point wire list through the harness geometry contained in the drawing.

- Calculates wire lengths by summing the lengths of the harness legs through which each wire is routed. Adjustments are applied based on a variety of design rules relating to the parts through which wires pass.
- Determines the cable sub-assembly structure that would save the maximum amount of labor in assembling the harness.
- Determines the optimum lay of wires in each harness leg and produces a cable cross-section drawing. Alternative lays of cables containing mixed diameter wires are automatically analyzed to identify the smallest

diameter and most even construction. In the example below the listbox contains the quantity of each wire diameter for which HamWare software has automatically developed 29 alternative design solutions. The minimum diameter alternative is shown which is 17.72 [.698] diameter and uses 2 fillers to achieve a sufficiently round lay.



HamWare Harness Design Software (Continued)



Part Selection

All the parts in a harness can be specified. The key steps in selecting parts include:

- Clicking a shape in the harness drawing or the design wizard.
- HamWare software automatically obtains design data and dimensions from the shape and from mating parts in the harness assembly drawing. In the case of a Raychem boot, for example, HamWare software extracts the required style of boot from the shape and the diameters from the mating harness leg and adapter.

- The database is searched for parts suited to the dimensional constraints. The choice is further refined by the service conditions which determine the best materials, finishes and adhesives. When alternative parts are found in the database, HamWare software offers the best option first which the designer can compare with the other alternatives. The on-line help systems contain details and advice on the various types of parts, materials and finishes and their suitability to different service conditions.

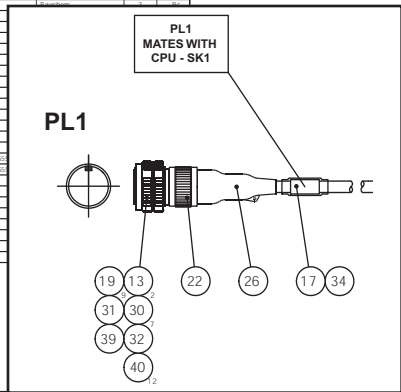
Among the parts that HamWare software helps to select are:

- Adapters
- Braid
- Connectors
- Databus couplers, etc.
- Feedthroughs
- Heat-shrinkable tubing
- Marker sleeves*
- Molded parts
- Adhesives
- Solder sleeves
- Wire

*Tyco Electronics Identification product information available at www.tycoelectronics.com

HamWare Harness Design Software (Continued)

PARTS LIST					
ITEM	DESCRIPTION	PART NUMBER	SPEC/REMARKS	QTY	UNIT
1	Wire	4441121-25-05-0	Raychem	30.2	M
2	Wire	4441121-25-05-0	Raychem	15.5	M
3	Filter	2.75MM SZF	Raychem	0.5	M
4	Filter	3.50MM SZF	Raychem	0.5	M
5	Braid	RAY101-310	Raychem	1.2	M
6	Braid	RAY101-323	Raychem	1.2	M
7	Braid	RAY1101-7	Raychem	1	M
8	Tubing	A1099-43	Raychem	2	PC
9	Tubing	DR-25-1.6-0	Raychem	1.6	M
10	Tubing	DR-25-1.0-30MM	Raychem	1	PC
11	Tubing	DR-25-1.0	Raychem	1	M
12	Tubing	DR-25-3.4-0	Raychem	0.6	M
13	Tubing	RNF-100-1.0-0.1MM	Raychem	4	PC
14	Tubing	RNF-100-1.0-0.20MM	Raychem	3	PC
15	Tubing	RNF-100-1.0-0.20MM	Raychem	1	PC
16	Tubing	RT-375-1.0-4-60MM	Raychem	1	PC
17	Tubing	RT-375-1.0-60MM	Raychem	1	PC
18	Tubing	RT-375-3.4-1-65MM	Raychem	1	PC
19	Insulation Cap	TC-4001-9	Raychem	1	PC
20	Adaptor	T19-408-800-1208A1	Raychem	1	PC
21	Adaptor	T19-408-800-1410A1	Raychem	1	PC
22	Adaptor	T19-408-800-2014A1	Raychem	1	PC
23	Adaptor	T19-408-800-1208B1	Raychem	1	PC
24	Moulded Part	2026-142-25-025-0	Raychem	1	PC
25	Moulded Part	2026-153-25-025-0	Raychem	1	PC
26	Moulded Part	2026-153-25-025-0	Raychem	1	PC
27	Moulded Part	2026-142-25-025-0	Raychem	1	PC
28	Substr Device	R-051-01-01	Raychem	1	PC
29	Substr Device	R-051-02-01	Raychem	1	PC
30	Substr Device	T1513-1-16-20-90	Raychem	1	PC
31	Marker Sleeve	TMS-AR501-NR19-4-C1-60	Raychem	1	PC
32	Marker Sleeve	TMS-AR501-NR19-4-C1-60	Raychem	1	PC
33	Marker Sleeve	TMS-SC1-1-2-0-4	Raychem	1	PC
34	Marker Sleeve	TMS-SC1-1-2-0-4	Raychem	1	PC
35	Marker Sleeve	TMS-SC1-2-0-4	Raychem	1	PC
36	Connector	D-3859-0501-010P	Raychem	1	PC
37	Connector	D-3859-0501-010P	Raychem	1	PC
38	Connector	D-3859-0600-105A	Raychem	1	PC
39	Connector	D-3859-0600-107P	Raychem	1	PC
40	Filler Plug	MS27488-20	Raychem	1	PC



Parts Listing

During the parts listing process HamWare software automatically:

- Extracts part details from the drawing
- Generates a sorted and totalized parts list table
- Adds item number balloons to the drawing cross referencing the parts to the parts list table.

HamWare software parts list data can be written to a structured text file ready for use in a variety of other systems including spread sheets, databases or word processors. The parts lists for a number of harnesses can also be combined to form a composite parts list that totalizes all the parts for a set of harnesses on a project. Other parts listing options include the ability to:

- Retain existing item numbers when a design is modified.
- Include gaps in the item numbering sequence.
- Convert part numbers to customer numbers or to VG or other industry standard numbers.

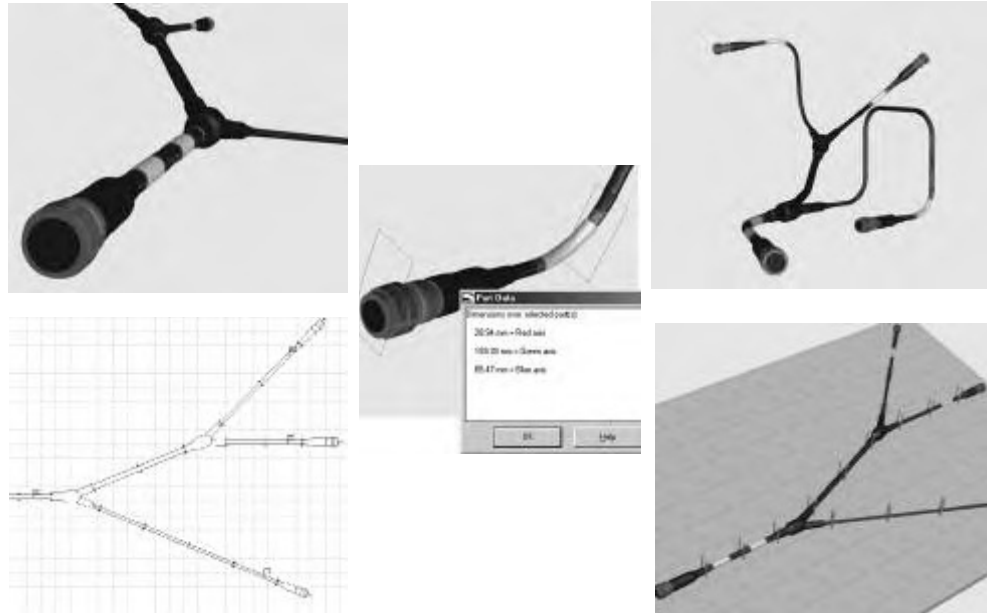
Other Features

Among the other HamWare software features and options are:

- 3D modelling system for visualizing harness designs. HamWare software automatically generates to-scale 3D models which provide virtual prototypes of harnesses designed. The user can see what a harness will look like with lengths, diameters and parts shown to scale thus reducing the potential for errors.
- Lay-up (nail) board designs. Harness lay-up board design can be modeled with pegs automatically positioned along the harness legs. Drawn output can be used on the lay-up board.
- Weight calculation. Most components weights are stored in the HamWare software database and this enables the software to estimate the weight of the harness.

2
Electrical Interconnection System Design

HarnWare Harness Design Software (Continued)

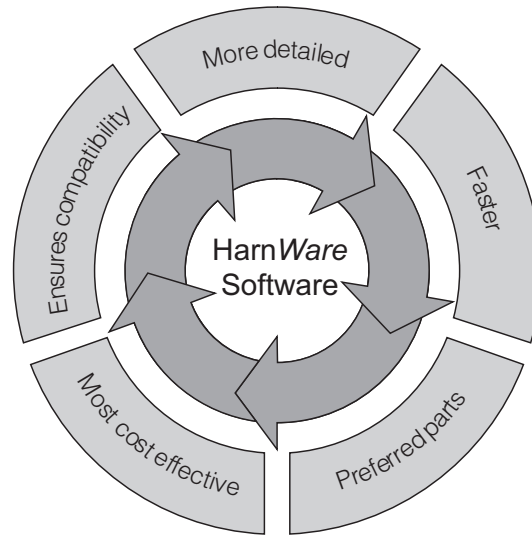


Other Features (Continued)

- **Labor estimator.** Harness drawings can be analyzed and details automatically added to a spread sheet containing assembly time standards. While estimating harness assembly times can never be an exact science, the estimates produced are sufficiently accurate for such purposes as comparing the cost effectiveness of alternative design solutions. A labor estimate is contained in the attached sample HarnWare software document set.
- **Cable analyzer.** This option analyzes the harness topology, wire lengths, etc. in order to suggest where machine, rather than hand, built cable sub-assemblies could result in the maximum cost savings.
- **Drawing translator.** Drawings can be translated into a number of foreign languages, including French and some Asian languages such as Korean and Japanese. Harnessing

- phrases, rather than individual words, are translated in order to achieve more meaningful and grammatically correct results.
- **Design checker.** This analyzes the contents and structure of a harness design against a set of rules. Where potential problems or deviations from 'best practice' are found, HarnWare software outputs a warning. The relevant parts in the harness design drawing can be flagged and the warning messages can also be listed in a table for use in design reviews. The warning flags and the messages are all linked to an on-line help system which contains further details on each specific problem.
- **Codes of practice.** A list can be generated of the codes of practice that are relevant to the parts included in the design. These describe harness assembly techniques and other issues.
- **On-line help system.** An extensive on-line help

- system covers system operating procedures and details on many aspects of harness design procedures and Raychem products. The help system is context sensitive and extensively cross-referenced using hyperlinks including links to the on-board manual or the Tyco Electronics website.
- **User parts library for non-standard parts.** A database to allow identification and retrieval of regularly used parts.
- **Multi-core cable database.** A database to allow selection of standard or regularly used cables.
- **Databus module.** Software for the design of ML-C-1553 databus harness assemblies using Tyco Electronics components.
- **Conduit module.** Software for the design of Tyco Electronics conduit harnesses.



System Integration

HarnWare software can be linked to many other computer systems using a variety of interfaces including:

- Parts list data can be exported in structured text files suitable for reading by such systems as spread sheets, databases and word processors.
- Drawings can be imported and exported using industry standard formats such as DXF and IGES.
- Cable marker data can be transferred to marker printing systems such as Tyco Electronics WnTotal* system.
- Wiring connectivity data export for test equipment
- X, Y coordinates of nail positions on lay-up (nail) board for NC drilling.

Benefits

The five key benefits of using HarnWare software are:

- 1) More detailed and accurate design.
- 2) Up to 20 times faster design and quotation.
- 3) Preferred part selection, to ensure best delivery and price.
- 4) More cost effective design.
- 5) Ensures parts are compatible with the intended service conditions and with mating parts.

Hundreds of users around the world can confirm the benefits of using HarnWare.

HarnWare Software

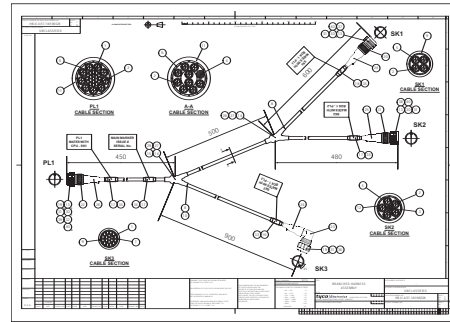
Document Set

The following partial set of drawings and associated documents is a simple example of what can be produced using HarnWare software.

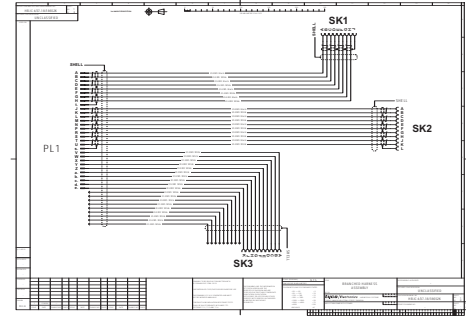
*Tyco Electronics Identification product information available at www.tycoelectronics.com

General Assembly, Wiring Schematic, Parts List, Labor Estimate, Marker Sleeve and Codes of Practice Pages

HamWare Harness Design Software (Continued)



General Assembly



Wiring Schematic

PARTS LIST						
ITEM	DESCRIPTION	PART NUMBER	SPEC/REMARKS	QTY	UNIT	
1	Wire	4481011-2029	Raychem	50.3	M	
2	Wire	4481117-20249-9	Raychem	15.6	M	
3	Fiber	2-12MM537	Raychem	0.5	M	
4	Fiber	3-50MM537	Raychem	0.5	M	
5	Braid	RAY100-100	Raychem	1.2	M	
6	Braid	RAY100-12.5	Raychem	1.2	M	
7	Braid	RAY100-7.5	Raychem	1	M	
8	Tubing	AT099-43	Raychem	2	PC	
9	Tubing	DR-25-1.0	Raychem	1.6	M	
10	Tubing	DR-25-1.2-0-50MM	Raychem	1	PC	
11	Tubing	DR-25-1.0	Raychem	1	M	
12	Tubing	DR-25-3.4	Raychem	0.6	M	
13	Tubing	8NF-100.0-0.0-10MM	Raychem	4	PC	
14	Tubing	8NF-100.1-0.0-20MM	Raychem	3	PC	
15	Tubing	8NF-100.3-0.20MM	Raychem	1	PC	
16	Tubing	RT-375-1.0-45MM	Raychem	3	PC	
17	Tubing	RT-375-1.3-65MM	Raychem	3	PC	
18	Tubing	RT-375-3.4-4-65MM	Raychem	1	PC	
19	Insulation Cap	TC-4001-9	Raychem	18	PC	
20	Adaptor	T8R-60A-80A-120981	Raychem	1	PC	
21	Adaptor	T8R-60A-80A-1410A1	Raychem	1	PC	
22	Adaptor	T8R-60A-80A-2014A1	Raychem	1	PC	
23	Adaptor	T8R76A-80A-120981	Raychem	1	PC	
24	Moulded Part	202K142-25-225-0	Raychem	2	PC	
25	Moulded Part	202K143-25-225-0	Raychem	1	PC	
26	Moulded Part	202K143-25-225-0	Raychem	1	PC	
27	Moulded Part	202K143-25-225-0	Raychem	2	PC	
28	Solder Device	B-051-01-01	Raychem	1	PC	
29	Solder Device	B-051-02-01	Raychem	1	PC	
30	Solder Device	S183-1-15-30-30	Raychem	1.4	PC	
31	Marker Sleeve	TMS-AR-500-AR19-4-C-1-65571	Raychem	4	KT	
32	Marker Sleeve	TMS-AR-500-AR19-4-C-1-65572	Raychem	1	KT	
33	Marker Sleeve	TMS-SCE-1-2-0-4	Raychem	1	PC	
34	Marker Sleeve	TMS-SCE-1-3-0-4	Raychem	2	PC	
35	Marker Sleeve	TMS-SCE-3-4-0-4	Raychem	2	PC	
36	C connector	645-B-6812-10P	Amphenol	1	PC	
37	C connector	D-38999-20801-000A	ML-C-38999	1	PC	
38	C connector	D-38999-20801-001A	ML-C-38999	1	PC	
39	C connector	D-38999-20801-017N	ML-C-38999	1	PC	
40	Fiber Plug	M527-488-20		20	PC	

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HARNESSES PROPOSAL DRAWING

TITLE: BRANCHED WIRE HARNESS PROPOSAL
 CREATOR: D-Hammond DATE: 13-03-01
 FILENAME: Pcham.vsd Page 3 of 8

LABOUR ESTIMATE							
Element	Time (mins)	Qty / Length	Total mins	Element	Time (mins)	Qty / Length	Total mins
Unpack Check & Cut/Prep	15	per set	0				
Jacket Stripping	5	per end	4				
Remove FPO Jacket	5	per end	20				
Identify Wires	1.5	per wire	60				
Strip & Insulate	2.5	per end	80				
Solder Wires							
Up to 12AWG (1/4" max length)	5.5	per term	10				
14 to 12AWG (1/4" max length)	5	per term	0				
Power Cable	15	per term	0				
Large Cable	15	per term	0				
Repair Cords	0.5	per wire	40				
Up to 65 Way Cords Above 55 Way Cords	0.75	per wire	0				
Subtotal			0				
Screen Termination							
Individual Term	14	per term	14				
Cable Term	0	per term	0				
Insulating Sleeves	2	per term	4				
Fiber Taps	20	per term	20				
Splice Wires	0.5	per wire	18				
Ring Tags & Strip	2	per term	0				
Ring Tags Solder	2	per term	0				
RT on Rings	15	per term	0				
Adaptors (Includes Braid Term Torque)							
Wiring	12	per term	0				
Heat	15	per term	0				
Wire/Cable Stripping	0	per term	0				
Tubing							
8NF-100	4	per term	0				
14 to 12	7	per term	1.50				
14 to 12	1.5	per term	1.43				
1/2 - 1/2	15	per term	0				
Wire VPE + 25%	0.25	per term	0				
21HM-25H	25	10 for 10	0				
Cable Stripping	25	10 for 10	0				
Tubing Installation on MARK Cut Harness	1	term	2.53				
Wire Layout							
Loop < 4 Meters	1		27.38				
20 - 30 wires	1.5		12.60				
30 - 40 wires	2		0				
Loop < 4 Meters	1.5		0				
20 - 30 wires	2		0				
30 - 40 wires	2.5		0				
1 Meter + to add 30% for reserved wire stock	1						
Enter 1 to Add Allowances for Prototypes:							
20% for Straight or Branched < 4 Ends	0						
35% for Branched 4 - 4 Ends	0						
tyco / Electronics HARNESSES PROPOSAL DRAWING							
TITLE: BRANCHED WIRE HARNESS PROPOSAL							
CREATOR: D-Hammond	DATE: 13-03-01						
FILENAME: Pcham.vsd	Page 5 of 8						

MARKER PAGE	
<p>PL1 MATES WITH CPU - SK1</p> <p>Item:34 Quantity:1 Part Number:TMS-SCE-1-2-0-4 Colour:Yellow Font:10 cpl Standard</p>	<p>SK1 MATES WITH BOX 1 - PL1</p> <p>Item:35 Quantity:1 Part Number:TMS-SCE-3-4-2-0-4 Colour:Yellow Font:10 cpl Standard</p>
<p>MAIN MARKER ISSUE # SERIAL No.</p> <p>Item:34 Quantity:1 Part Number:TMS-SCE-1-2-0-4 Colour:Yellow Font:10 cpl Standard</p>	<p>SK2 MATES WITH BOX 1 - PL2</p> <p>Item:35 Quantity:1 Part Number:TMS-SCE-3-4-2-0-4 Colour:Yellow Font:10 cpl Standard</p>
	<p>SK3 MATES WITH BOX 1 - PL3</p> <p>Item:33 Quantity:1 Part Number:TMS-SCE-1/2-2-0-4 Colour:Yellow Font:10 cpl Standard</p>

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HARNESSES PROPOSAL DRAWING

TITLE: BRANCHED WIRE HARNESS PROPOSAL
 CREATOR: D-Hammond DATE: 13-03-01
 FILENAME: Pcham.vsd Page 6 of 8

CODES OF PRACTICE, FAX-ON-DEMAND AND DRAWING NOTES	
Code	Description
251	End stripping primary wire and cable
254	Stripping wire and cable jackets
256	Laying hand laid sections of harnesses
257	Applying Kevlar binder to hand-laid sections of harnesses
261	Preparing shielded and jacketed wire
301	Looping wire gauges 18 and below
368	Terminating a primary wire to a cable shield using a solder sleeve with a pre-installed lead
361	Applying a single layer of braid to a hand laid cable
362	Terminating overall shields formed by single layers of braid at a transition
511	Installing heat shrinkable tubing
610	Preparing cable jackets for the installation of pre-coated tubings
359	Installing Tinel-Lock rings with a resistance heater
366	Positioning Tinel-Lock rings
451	Applying Loctite sealants to Raychem adaptors
452	Torque tightening Raychem adaptors
553	Installing medium and large transitions
554	Installing straight lipped boots
557	Under jacket packing for moulded parts
558	Installing moulded parts using Unicure adhesive
603	Preparing cable jackets and adaptors for installing moulded parts
609	Preparing non-shielded moulded parts
556	Installing marker sleeves
454	Checking the retention of pins or sockets within a connector

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HARNESSES PROPOSAL DRAWING

TITLE: BRANCHED WIRE HARNESS PROPOSAL
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